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Ceylon.

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EDITORIAL

This number of the *Tea Quarterly* has been delayed in order to avoid having two numbers in the press at one time; the previous number was delayed by waiting for the discussions to take place at the Biennial Conference in January. We hope that the press will make up time and that the September number, at any rate, will appear at the proper date, in the middle of the month.

Discussions at conferences are very troublesome to edit for printing; what people say in unprepared speeches has to be heard (on the tape recorder) to be believed. This remark is not made to attract sympathy, but rather to explain why questions and answers are not necessarily given in their original form but are altered to provide readable matter. Even now some questions that were asked do not appear at all, sometimes because they are answered in the polished-up version of the paper printed here, and sometimes because they are completely unanswerable. If any questioner feels aggrieved, we hope he will write to us and ask his question again, after reading the relevant paper.

It will be noticed that some of the conference papers have still not appeared. Rather than have one bulky Conference Number, with a long gap in time on either side, we have spread the papers over three numbers.

In the present number, the first stage of the shade-tree controversy appears, with later stages to follow. It cannot be emphasised too heavily that this is a discussion and *we are not recommending any changes in shade-tree practices at present.* Further, to avoid misunderstanding, we are marking the relevant articles as copyright and not to be quoted without specific permission in writing.

To balance these rather theoretical papers, there are very practical papers on blister-blight control using sunshine recorders and mechanized mist-blowers. There are also letters from planters. We are very glad to see that planters are increasingly writing to us for this feature. We can afford to give more space to them.

*THE SHADE-TREE QUESTION AND GREEN MANURES

A. W. R. Joachim

Introduction

It is not my intention in this paper to dilate on the several advantages of green-manure and shade trees in relation to tea cultivation, as these are well known and have been detailed at earlier Conferences. Nor do I propose to discuss such fundamental matters as shade *per se* in relation to tea agronomy, for this will be dealt with by my colleague, Dr Visser. My purpose is primarily to review the shade-tree and green-manure question in relation to the main theme under discussion, *viz*, organic matter and tea soils, with special emphasis on (*a*) the nutritional aspects of this agricultural practice, (*b*) its effects on the moisture status of the soil and on the crop, and inter-relationship between shade trees and green manures on the one hand and the response of the tea to artificial fertilizers on the other.

Shade trees and green manures, particularly of the leguminous species, have been cultivated in tea from the earliest times, no doubt because of their association with the crop in its natural habitat, and probably because of knowledge of the beneficial effects of this group of plants on the maintenance of soil fertility and the impracticability of cultivating them in a perennial crop like tea otherwise then as an *inter-planted* crop. Except for *Grevillea robusta*, among high shade trees and, to a very limited extent, *Tecoma stans* among medium shade trees, the species now used in this manner in Ceylon are all leguminous. Bush green manures like *Crotalaria* and *Tephrosia* species are generally grown in young tea and new clearings, and only for a period of a year or two. As regards cover crops, though several trials have been made over the years, there has been little success in the search for a suitable leguminous species that would protect the bare soil against erosion and exposure to the sun (particularly in the early stages of the cultivation of the crop) and would have none of the disadvantages of such crops, *e.g.* competition for moisture and plant food, climbing over the bushes. Species like *Indigofera endecaphylla*, *Desmodium ovalifolium*, *Stylosanthes gracilis* among leguminous species, and *Centella asiatica* (Gotu-kola S.) among non-legumes, have, at one time or another, been recommended as a cover for tea, but their utilisation has never been extensive nor universally advantageous. Selective weeding thereafter came into favour, but only in certain areas. With the adoption of much closer planting, particularly in the low country, and the cultivation of vegetatively propagated (V.P.) tea with its dense soil-cover, the question of cover crops has become much less important.

The Nutritional Aspects

From the nutritional point of view the main functions of *green-manure* trees, bushes, and covers, in tea cultivation are: (1) to supply the soil with bulky organic matter in large quantities and thus replace the heavy and rapid losses which take place under tropical conditions; (2) to make nitrogen and mineral nutrients available in a cheap and relatively slowly-available form; and (3) to help to maintain soil structure and its micro-biological population, both closely connected with its fertility. It is preferable to use leguminous species for green-manure purposes as

many of these have the property of being able to fix the nitrogen of the atmosphere through the nodules on their roots. Little, however, is known of the actual amounts of nitrogen which these plants fix in the acid soils under which tea is cultivated; but that trees have a beneficial effect is evidenced by the fact that, in Ceylon until about 30 years ago, tea estates have been known to have produced relatively good yields of crop, merely by growing high shade trees like *Grevillea* and medium shade trees like dadap for lopping and incorporation of the bulky material with the soil. Holland (1931), who was Manager of the Experimental Station, Peradeniya, where all the early experimental work on tea was conducted, reported that "plots which have received no nitrogen for years other than that obtained from dadap loppings have throughout maintained their yield and healthy appearance". The green material can either be turned into the soil or used for mulching. A small proportion of nitrogen may be lost if it is used for the latter purpose, but the benefits of soil and moisture conservation which a mulch confers should more than counterbalance this disadvantage.

Some tree species grown in tea are mainly cultivated for providing shade, but the quantity of organic matter which they may supply can be considerable. In East Africa, where *Grevillea* is used as shade, it has been reckoned that about 6½ tons of dry matter per acre are contributed as a mulch by the natural leaf fall, including that of tea (Goodchild & Foster-Barham, 1958). Visser (1960) estimates leaf fall from tea in Ceylon to be about a ton per acre per annum. The contribution of the *Grevillea* may, therefore, be very substantial.

A great advantage of these shade-tree species is that, rooting much more deeply than tea generally, they are able to forage for nutrients from the lower soil depths which they later make available to the tea through their loppings. This may be a matter of vital importance in respect of the supply of minor elements to the tea, especially so when V.P. tea giving yields of over 2,000 lb. per acre is cultivated on a large scale. Table I below shows the comparative amounts of nutrients removed by an acre of tea yielding 1,000 lb. and those contained in green-manure loppings from species grown on the same land, *viz, Gliricidia sepium*, dadap (*Erythrina lithosperma*), and *Albizzia moluccana*. The actual amounts of loppings which green-manure species can yield will vary with the species, spacing, locality, frequency of lopping, etc. Generally speaking, the total amount will not be less than 5 tons of green material per acre, but Holland and Bamber (1931) reported that with *Gliricidia* planted 16′ × 16′ and lopped 3 to 4 times a year, as much as 10 tons per acre of loppings per annum were obtained under Peradeniya conditions. With dadap the yields were lower and varied from 4 to 6 tons per acre. The analytical figures shown in the table are calculated on the low average basis of 2 tons of *Gliricidia*, 1 ton of dadap, and 2 tons of *Albizzia* loppings per acre per annum which are representative of yields obtained on two low-country estates with a rotational system of lopping of alternate trees of these species two or three times a year. I am indebted to Mr J. A. H. Tolhurst, Agricultural Chemist, for the analytical data from which these figures were calculated. Reference has also been made to Child's data on East African tea leaf (Child, 1957).

TABLE 1.—*Amounts of Nutrients*

	Tea at 1,000 lb. per acre removes	Green manures return:			
		Gliricidia (2 tons per acre)	Dadap (1 ton per acre)	*Albizzia* (2 tons per acre)	Total per acre
Nitrogen	40 lb.	35 lb.	31 lb.	30 lb.	96 lb.
Potash	20 ,,	25 ,,	17 ,,	14 ,,	56 ,,
Calcium oxide	7 ,,	14 ,,	6 ,,	20 ,,	40 ,,
Phosphoric acid	8 ,,	5 ,,	6 ,,	3 ,,	14 ,,
Minor Elements					
Copper	0.32 oz.	0.27 oz.	0.53 oz.	0.43 oz.	1.23 oz.
Molybdenum	0.016 ,,	0.011 ,,	0.0027 ,,	0.021 ,,	0.035 ,,
Zinc	0.40 ,,	0.052 ,,	0.044 ,,	0.06 ,,	0.16 ,,
Boron	0.48 ,,	0.56 ,,	0.25 ,,	0.41 ,,	1.22 ,,

A glance at the figures will show that green manure loppings do circulate quantities of nutrients far in excess of those removed in the tea crop (except for the minor element zinc), even after taking into consideration the fact that about a third of these nutrients may be lost by the removal of the woody branches. It should be pointed out, however, that the natural leaf-fall from the tea bushes and the foliage from the prunings will also return to the soil about twice the amount of nutrients removed in the crop. Even so, the use of green-manure trees will be of benefit to the tea from this standpoint.

While on the subject of minor elements, reference may be made to recent findings that boron deficiency in the soil can cause diseased conditions in *Grevillea* grown as shade in certain tea areas of East Africa and in plantations of black wattle (*Acacia* spp.) (Smith, 1960; Elmer & Smith, 1960). The symptoms are a die-back of the tip and of branches near the apex, followed by defoliation, sprouting of branches from the lower part of the trunk and, in advanced cases, the cracking of the bark and gummosis. They are accentuated by successive periods of drought. The condition has been cured by the application of small quantities of borax to pollarded trees. Whether this condition exists in any of our tea areas up-country I cannot say, but I understand that on one or two estates in Uva a somewhat similar condition was reported some time ago and the cause was not diagnosed. In drawing attention to this matter, I must not, however, be understood to infer that I advocate the application of boron to tea in Ceylon. This is certainly not the case. All I intend to indicate is that a minor element—in this instance boron—can be of importance, at any rate in one aspect of tea agronomy.

Before passing on to another aspect of the subject, reference may be made to the question of the frequency of lopping. In practice this is determined by a number of factors such as rate of growth, availability of labour, etc. From a theoretical standpoint, however, the object should be to obtain the maximum amount of decomposable green material containing the highest amounts of nutrients. Waksman & Tenney (1928, 1929) showed years ago that when the nitrogen content of a material is about 1.8 per cent, it is just sufficient to cover the requirements of the micro-organisms active in the decomposition of plant material. An investigation carried out on this subject in 1931 showed that under Peradeniya conditions the optimum intervals for lopping *Gliricidia* and dadap branches were about 4 and 5 months respectively (Joachim & Kandiah, 1934). These would obviously vary with the district.

The Moisture Status of Soils and Green Manures

Now to a discussion of the moisture status of the soil in relation to green-manure crops and tea. One disadvantage of green manures, whether tree, bush, or cover crops, is that they compete with the main crop for nutrients and for moisture. In the case of the former, apart from the timber they are returned to the soil in the loppings, but the competition for moisture can be serious in times of drought. The leaves transpire water and the amount lost by the soil through this source may exceed the amount conserved as a result of the shade afforded or the mulch provided by the leaf fall. Experiments carried out at Peradeniya by Joachim & Holland (1927) on a cover of *Indigofera endecaphylla* in tea showed that at the early stages of growth of the cover, more moisture was lost from the soil by transpiration than was conserved by the crop, but after the cover had been well established (in about 2 years) the reverse process occurred. The mulch on the surface had brought about this desired result. The adverse results noted by Visser (1960) of a cover of *Stylosanthes gracilis* in young tea on a sandy soil at the Neuchatel V.P. Station can well be understood. This crop is now generally reported to be unsuitable for inter-cultivation with tea.

As regards bush crops such as *Crotalaria* spp., where these were permitted to grow without lopping, a similar result has been obtained both in Ceylon and in Nyasaland (Laycock, 1957). Bush crops can be grown in young tea, but they should be lopped to a reasonable height occasionally and the loppings used as a mulch.

As regards the tree species the problem is similar. Investigations carried out at Peradeniya (Joachim & Kandiah, 1931) showed that with *Gliricidia* and dadap, these green-manure species were advantageous in the early stages of the drought. But when the drought was severe and of prolonged duration, the soils under the green-manure trees were found to contain somewhat less moisture than the bare soil to a depth of 2 feet. The same result may not, however, be obtained under other conditions. Arising from these findings it would appear advantageous before normal periods of drought, particularly in marginal rainfall areas, to lop alternate shade trees and to use the loppings as a mulch on the surface. Neglect of this precaution has been very adverse to the tea.

Where, however, the natural leaf-fall from certain species is heavy, as in the case of *Grevillea,* the mulch so formed could counterbalance any adverse moisture effects. In East Africa, this mulch has been reported to increase yields of tea significantly. (Goodchild and Foster-Barham, 1957, 1958).

The Inter-Relationships Between Shade and Fertilizer Response

To consider now the inter-relationships between green-manure and other crops used as shade for tea and the response to artificial fertilizers under these conditions. The classical work started by Cooper (1939) in Assam and continued by Wight (1959), Dutta (1956) and others on the effect of shade on tea, has demonstrated without any doubt that tea of some *assamica* types benefits markedly from shade. Increase in yield obtained in a number of experiments varied from 15 to 35 per cent. over the control without shade, whether or not artificial fertilizers were used. The shade trees grown in these instances were all leguminous. In the one case where a non-leguminous species was used, *viz, Aleurites montana,* there was no benefit reported from the shade. Whether the increased yields are due to the shade *per se* or to the nitrogen fixed by the leguminous species or to both cannot be stated categorically. Wight (1959) holds the view that a large part of the effect of leguminous trees on yield can be ascribed to shade. But he also states in respect of the results of Cooper's trials carried out over a period of 10 years with the leguminous tree sau (*Albizzia chinensis*) that "the yield increments due to sau trees are equivalent to those obtained from about 80 lb. of nitrogen per acre per annum". Wight further observes that subsequent detailed analysis suggests that a stand of sau trees is probably more than twice as effective as 80 lb. nitrogen as sulphate of ammonia "in terms of the yield of real bush surface of mature tea".

TABLE 2. *Response of Tea Under Shade to Nitrogen*
(*sau, Albizzia chinensis*)
(Wight, 1959)

	Average yield (1942–1951) lb. leaf per 100 bushes	
	Sau trees	Full sun
Ammonium sulphate (84 lb. N. per acre)	274	206
No fertiliser	230	116

Cooper's experiment also demostrates that: (1) if shade trees are not used, large amounts of nitrogen are necessary to give equivalent yields, and (2) the return of tea per pound of nitrogen is less under shade trees than in full sunlight. The latter finding has been confirmed by other workers. Thus in East Africa, experiments carried out at the Kericho tea experiment station (Goodchild & Foster-Barham, 1958, 1959) have demonstrated that under *Grevillea* shade, tea shows no yield response to nitrogen applied in amounts varying from 40 to 120 lb. per acre per annum (*see* Table III below). In Ceylon, too, Eden (1949) reported that at St Coombs on a "normal Grevillea-shaded area, 9 years of manurial treatments varying by 30 lb. of nitrogen have failed to show any effect". But experience on estates in Assam with the nitrogenous manuring of tea under shade has been very variable and conflicting results have been reported. On the other hand, tea in full sunlight—that is, without shade—whether in India, Ceylon, or East Africa—has shown marked benefit from applications of nitrogen as sulphate of ammonia, the response being linear even up to 150 lb. of nitrogen per acre in a few instances.

TABLE 3. *Shade and Manuring*

Trials at Kericho, Tea Research Institute of East Africa

Nitrogen (per acre per annum)	Average Yields (lb. per acre per annum)	
	Shaded (1955-58)	Unshaded (1956-59)
Nil 40 lb.	1,208 1,220	1,135 1,297
Nil 80 lb.	1,208 1,214	1,135 1,412
Nil 120 lb.	1,208 1,233	1,135 1,416

As an explanation of these varying results, Wight (1959) supports Cooper's idea and suggests that shade and nitrogen are "equivalent and interchangeable in their effect on tea" (Eden, 1958), and that the degree of response of shaded tea to nitrogen is dependent on the *agrotype* cultivated. While one agrotype may respond well to nitrogen under shade, another may give no response whatsoever. Accordingly, Wight considers that the varied results obtained on estates with nitrogen in shaded tea are due to (i) differences in degree of shade intensity, and (ii) the agrotypes cultivated and their proportions on each estate. That such variations in response to nitrogen do also occur in shaded tea in Ceylon will be noted when my paper on the responses to manuring in the low-country is discussed.

With regard to the response of tea under shade to phosphate it can be said that in a number of trials a beneficial response to this nutrient has been observed when used alone or in combination with nitrogen.

Conclusion

In conclusion, I would commend for study the valuable note by Mr R. K. Christie (1960) on "Green Manure and Shade Trees". I agree with him that "we have little accurate knowledge of the true function of shade trees in tea culture

in Ceylon". In view of this, and of what I have indicated, I think that greater attention could be given in our future research programme to the shade problem, and, in particular, to the inclusion of the shade factor in manurial and clonal trials. The appointment of a soil microbiologist, even on a temporary assignment, to unravel the problems connected with nitrogen fixation in tea soils, would, I think also be distinctly advantageous.

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*INTERPLANTING IN TEA

1.—EFFECTS OF SHADE TREES, WEEDS, AND BUSH CROPS

T. Visser

1. Introduction

As shade trees have been traditionally planted in tea for many years, it is no wonder that their uses have often been discussed in the recent past (Walter, 1950; Portsmouth, 1951; Eden, 1952) and are still a subject for discussion at this Conference in which Dr Joachim (1961) has preceded me. More stress has been laid on their advantages than on their disadvantages, though more recently Christie (1960) has expressed some doubts as to their usefulness.

Apart from the undeniable fact that the trees provide shade, much of what has been said about shade trees has been presumptive and biased by the concept that tea is a "shade-loving" plant. Therefore, it seemed that an approach which questions rather than accepts the desirability of interplanting tea with shade trees might be more fruitful.

The discussion in this paper will be restricted to soil moisture, the mobilisation of nutrients, the supply of organic material to the soil, and the effects of weeds and cover crops. The influence of shade *per se* and its interaction with fertiliser applications will be reviewed later.

2. Shade-Tree Effects

2.1. Soil moisture relations under shade trees

Do shade trees conserve moisture during drought conditions? Opinion among planters is divided on this question. It is true that, on the one hand, shade trees, if unlopped, will lower the transpiration rate of tea, but on the other they will transpire a considerable amount of water themselves, which may exceed the amount conserved indirectly. This aspect of shade trees has been mentioned by Joachim (1961), who also observed that *Gliricidia* and dadap trees conserved moisture during the beginning of a drought but adversely affected it when the drought was of prolonged duration.

In Nyasaland (Anon., 1960), soil-moisture determinations in unshaded tea and in tea shaded by *Grevillea robusta*, *Gliricidia maculata* and *Albizzia gummifera* showed that there were only small differences in soil moisture in the first foot. Below 5 ft. the moisture available under *Grevillea* and *Gliricidia* was slightly less and that under *Albizzia* markedly less than when no shade was present. Presumably, the water evaporated by the *Gliricidia* was nearly balanced by the saving in evaporation of the tea under the fairly heavy shade provided by *Gliricidia*. The more vigorously-growing *Albizzia*, however, did not save as much moisture by shading the tea as it evaporated itself. Other data on soil-moisture effects of *Grevillea* and *Albizzia* in coffee (Anon., 1960a) and *Grevillea* in tea in South India (De Jong, 1950)

showed that *Grevillea* competes less for moisture than *Albizzia* does and may even conserve a little in tea.

Removal of foliage drastically curtails the moisture requirements of a tree. The magnitude of the reduction in water uptake is indicated by soil-moisture determinations done on pruned and unpruned tea during the dry season in Nyasaland (Anon., 1959, 1960). Clean pruning delayed the depletion of the moisture reserves to the wilting point by 6–10 weeks as compared with no pruning. The favourable effect of defoliation by pruning is also reflected in the subsequent death rates of young tea plants after drought: clean-pruned (6%), cut-across (14%), and unpruned (31%).

Trees that are lopped at the start of a drought use less moisture but of course they no longer provide shade. Leaves of tea exposed to full sun may heat up by 4°C (say 7°F) above air temperature (De Haan, 1938; Hanipi & Reesinck, 1959). This can contribute to scorch of leaves. It has also been observed that tea pruned into the dry weather in Nyasaland recovered twice as quickly under shade as without shade (Child, 1960).

2.2. Shade trees and the nutrition of tea

It has been implied that shade trees assist the tea in obtaining extra minerals and nitrogen (Eden, 1952; Joachim, 1961). First, it is assumed that the shade trees have a more robust root system and can penetrate soil layers that are impervious to tea roots; and where the tree roots go the tea roots might follow. Second, it is assumed that the shade trees, by allegedly exploiting deeper soil layers, can bring up essential nutrients and deposit them on the soil surface in their leaf fall and loppings, and thus provide a valuable system of nutrient rotation.

Since these observations are based on speculations rather than on hard facts, they require closer scrutiny.

(*a*) When the tea has been planted on forest land, shade trees are unlikely to be of any *further* assistance to root penetration, because the forest trees have already opened up the soil.

(*b*) On the non-proven assumption that trees root more deeply than tea, it still remains questionable whether they would also effectively exploit the deeper soil layers. This would presume that mineral deposits are not exhausted there or are replenished by sufficient quantities of leached-down fertilisers.

(*c*) There are no grounds for believing that shade trees are any better equipped than tea is to overcome those adverse conditions that limit root depth, such as water logging, lack of aeration, hard pans, etc.

(*d*) When most of the nutrients are to be found and applied on the soil-surface layers, it is more than probable that the main feeding-root systems will be at the same depth for tea bushes and for shade trees.

As is shown by figures given by Joachim (1961), considerable amounts of N, P, K, and other elements are returned to the soil in the form of loppings, but these as well as the minerals locked up in the tree structure, are probably obtained in competition with the tea. This view is not held by Eden (1952), who states that the competion for nutrients by shade trees is not of great importance. His view

assumes that the nutrients locked up by the tree can be neglected and that, in case of leguminous shade trees, the net nutrient gain from nodule-fixed nitrogen is of some consequence.

Taking *nitrogen fixation* first, there is considerable doubt whether this occurs to any great extent under conditions of heavy nitrogen manuring. Greaves and Jones (1950) state that legumes feed preferably on available nitrogen and turn to atmospheric nitrogen only if soil nitrogen is reduced to a level where it cannot meet the needs of the plant. Pot experiments by Allos and Bartolomew (1955) with seven leguminous crops showed that manuring with sulphate of ammonia at equivalent rates of 0, 26, 52 and 75 lb. N/acre every ten weeks (sampling 6″ deep) depressed the N–fixation on an average by 0, 34, 53 and 70% respectively. Although N–fixation was thus reduced, at the very high rate of manuring of 390 lb./acre/annum, it did occur to an extent of 30% of the maximum. Thornton (1947) showed that the amount of nitrogen fixed by two leguminous crops was inversely proportional to the amount of inorganic nitrogen supplied to the plant. Norman and Krampitz (1946) found that for the soya bean crop, fixation of atmospheric nitrogen did not amount to more than 30 to 40% of the total absorbed, if nitrogen is given in quantities about equal to or in excess of that absorbed. A similar phenomenon was observed for non-symbiotic nitrogen-fixing organisms, such as *Azotobacter*, of which the fixation was found to be suppressed at nitrate concentrations exceeding 28 to 42 lb N per acre (Delwiche & Wyler, 1956). It seems probable, therefore, that under conditions of generous nitrogen applications, as in Ceylon, leguminous shade trees may fix reduced but still significant amounts of atmospheric nitrogen.

When no manure is supplied, leguminous shade is certainly advantageous, as has been found by Dutta and his co-workers (1954, 1958, 1959) in an experiment on the long-term effects of seven different shade-tree species on the yield of unmanured tea.

TABLE 1.—*Annual yield in lb made tea per acre (averaged over 10 years) of unmanured tea respectively unshaded and shaded by leguminous (Albizzia stipulata) and non-leguminous (Aleuritis montana) trees*

Unshaded (1)	*Aleuritis montana* (2)	*Albizzia stipulata* (3)
970	1,000	1,170

The difference between (1) & (2) is not significant; between (1) & (3) and (2) and (3) it is significant for most years.

Table 1, from Dutta *et al*, shows that the tea shaded by a leguminous tree yielded annually 170 lb more tea than tea shaded by a non-leguminous tree of about equal vigour (height); the latter yielded about the same as unshaded tea. Thus, at least when tea is under-manured, leguminous shade trees are preferable to non-leguminous species.

With regard to the competition between shade trees and tea, for nutrients, we determined the total dry weight of two *Grevillea robusta* and two *Albizzia moluccana* trees (age 8–12 years) growing in old tea, as well as the N, P, K contents of the different tree parts. Table 2 gives the dry-weight figures and amounts of N, P, K per acre, calculated on the basis of 35 *Albizzia* (at 35 ft. square) or 60 *Grevillea* trees (at 29 ft. square) per acre.

TABLE 2.—*Amounts of dry matter and N, P_2O_5 and, K_2O in lb per acre provided by the various parts of Grevillea robusta and Albizzia moluccana trees (about* 10 *years old)*

Tree part	*Grevillea*				*Albizzia*			
	Dry wt.	N	P_2O_5	K_2O	Dry wt.	N	P_2O_5	K_2O
Leaves & twigs	1,990	30.5	7.5	20.3	2,020	42.1	10.5	21.3
Branches	2,910	9.1	2.8	24.1	2,840	8.9	2.7	27.8
Trunks	12,000	37.4	15.6	71.7	20,200	64.3	16.5	77.4
Roots	4,960	15.6	6.0	40.4	9,020	28.2	11.8	59.3
Total:	21,860	92.6	31.9	156.5	34,080	143.5	41.5	185.8

Table 2 shows that considerable quantities of N, P, and K are present in the various tree parts, the greater portion of which is locked up in the permanent tree structure (branches, trunk, and roots). This averages 8 lb N, 3 lb P O^5 and 15 lb K_2O per annum per acre, which is possibly an under-estimate for these 8–12 year old trees, as Lamb, Portsmouth and Tolhurst (1955) estimated that *Albizzia sumatrana* trees(timber + roots) had taken up 83 lb N, 9 lb P_2O_5 and 174 lb K_2O per acre in three years after planting.

If it is assumed that the tea field from which the trees came, which yielded about 900 lb tea annually, was manured at the recommended ratio (Lamb *et al*, 1955), it can be calculated that on an average 11% N, 8% P_2O_5 and 39% K_2O of the total amount applied had been immobilized by 10-year-old shade trees. These figures indicate that relatively small amounts of nitrogen and phosphate but a considerable amount of potash is more or less permanently removed from circulation by the trees.

A better insight into the nutrient balance of a tea field interplanted with shade trees is obtained when both losses and returns of nutrients are considered. For this purpose we made use of our own data, calculating losses (permanent tree structure) and returns (leaves + twigs) on an annual basis; the latter estimations were used in combination with the data given by Joachim (1961), on the assumption that usually two shade-tree species would be interplanted. Furthermore, use was made of data on the removal and returns of nutrients by made tea (Eden, 1949; Vermaat, 1950; Child, 1957), foliage (Eden, 1949; Tolhurst, 1960) and prunings (Eden, 1949). Lastly it was assumed (*a*) that 1,000 lb made tea was produced per acre per year; (*b*) that foliage and prunings amounted to 0.8 and 1.1 ton per acre annually (Visser, 1960); (*c*) that 1/3rd of green loppings constitue dry matter; and (*d*) that the tea was manured at the standard ratio of 8 lb N in T. 500 form per 100 lb tea (*see* Tables 3 and 4).

TABLE 3. *Estimated annual nutrient balance of tea bushes and shade trees; dry weight in tons per acre, nutrients in lb per acre*

LOSSES					RETURNS				
Due to	Dry wts.	N	P_2O_5	K_2O	Due to	Dry wts.	N	P_2O_5	K_2O
Made tea	0.45	38.0	7.4	19.2	Tea foliage + prunings	1.9	57.1	11.7	35.2
Albizzia Wood	1.4	10.1	3.1	16.5	Loppings of *Alb. + Glir.*	1.6	71.0	18.7	42.0
Grevillea Wood	0.5	6.2	2.4	18.6	Loppings of *Grev. +Dadaps*	1.4	61.5	13.5	37.3

TABLE 4. *Estimated differences between amounts of nutrients per acre applied as fertilizers and those removed annually by 1000 lb made tea, prunings, and an average stand of medium-age shade trees in lb per acre*

1	2	3	4	5	6	7
Nutrients	Made tea	2/3rd of prunings	Wood of shade trees	Total taken up	Total applied	Balance of deficit
N	38.0	15.8	8.2	62	79	+ 17 (22%)
P_2O_5	7.4	4.7	2.7	15	39	+ 24 (62%)
K_2O	19.2	12.5	17.5	51	45	— 6 (13%)

The main picture which emerges from Table 3 (left half) is that the shade trees take away as much potash as the tea flush does, but they take away much less phosphate (about 1/3rd) and nitrogen (about 1/5th) than tea does. In both cases these losses have to be made up by chemicals. These figures have a rough qualitative value only, as they do not take into account possible returns by the decomposition of tree roots nor the possibility that two tree species may be present, causing greater losses.

On the returns side (right half of Table 3) it would appear that tea bushes and a mixed stand of shade trees are similar in the amounts of N, P, K that they put back into circulation. Also, in this case, some reservations must be made. With regard to the tea, the quantities returned by prunings were included, but the bulk of these are often removed by the labourers. The returns by shade trees are obviously dependent on their spacing and age, and on the severity and frequency of lopping. It will be seen from Table 4 (columns 5, 6, 7) that, assuming no losses of fertilizer by leaching out of the soil, the nitrogen margin, though narrow, is positive and would be supplemented to some extent by fixation of leguminous shade trees; the amount of phosphate applied may be excessive; and the amount of potash taken away by shade trees is so large that it may be desirable to increase the amount of it in the mixture applied. These ideas are supported by unpublished partial correlations from twelve estates totalling over 10,000 acres for 1951–57: yield and N gives + 0.987; yield and K gives + 0.697; yield and P gives + 0.070.

Micronutrient (zinc, boron, manganese) turn-over has been dealt with by Tolhurst (1960), who showed that ample is returned in the tea foliage.

Finally, mention must be made of the fact that it has been found possible to obtain reasonably good yields of tea for a considerable length of time *without manuring*, but *with a good stand of shade trees*. Although this phenomenon will be extensively discussed in my second paper (Visser, 1961), it is opportune to state here that this has little to do with the alleged role of shade trees as providers of nutrients which the tea on its own cannot obtain, because similar effects are obtainable under artificial shade. According to figures quoted by Barua (1960) on five long-term field experiments, yield increases of between 38% and 135% have been recorded following the shading by bamboo screens of unmanured tea. These increases can be attribtuted to the effect of shade *per se*, which markedly reduces the nutrient requirements of the plants. However, it should be realised that the yield under shade with no manuring will be less, as is borne out by a shade-tree trial of Dutta and Heath (1954), which shows a drastic drop in yield after manuring was stopped.

2.3. SHADE TREES AND SOIL FERTILITY

Do shade trees substantially contribute to the nitrogen or organic matter status of the soil?

Sampling of unshaded tea and of tea shaded by *Albizzia* in Nyasaland (Anon., 1955) showed that in one location unshaded soil contained 0.13% N as compared with 0.18% N for shaded tea soil. On other estates, no differences were found between soil shaded by *Grevillea* or *Albizzia*, but N-contents were higher (by 10%) than where there was no shade, while organic matter percentages were about 20% higher.

Gokhale (1960) investigated total soil nitrogen contents of a 3-ft profile in unshaded tea and in tea shaded by *Albizzia chinensis* (with N, P, K treatments). He found after 15 years continuous treatment that total nitrogen for the unshaded tea was only 5.5% lower than that of shaded tea. Other observations of Gokhale (1959, 1960) showed that manuring, especially with nitrogen, has a markedly favourable effect on the N-status of the soil. He found that unshaded and unmanured tea soil lost, over a period of 27 years since planting, 41% of its original nitrogen as compared with a loss of 27% for the same soil manured at a rate of 120 lb N (plus 60 lb P & K).

The approximate gain of 5% in soil nitrogen due to the presence of shade trees does not seem large, but on Gokhale's determinations (personal communication) may amount to as much as an annual fertiliser application of 40 lb N (plus 20 lb P & K). However, it should be kept in mind that in Assam both annual pruning and fish-leaf plucking are practiced, so that the contribution made by the tea to soil organic matter is much less than when pruning cycles are longer and plucking is less severe.

When the starting point of a plantation is a jungle soil, certain losses in nitrogen are unavoidable, because tea obviously cannot replace a forest, as is clearly illustrated by the findings of Tolhurst (1961). However, Gokhale's graphs show that generous nitrogen applications stabilise the N-content not only at a higher level, but also sooner than when little or no fertilizers are applied. Figures given by Eden (1947, 1949) on St Coombs soils indicate that if the soil is less fertile (as for example is the case with many patana soils in Ceylon) tea cultivation may even significantly improve the soil nitrogen and organic matter contents.

It should be understood that loppings from shade trees are not the only source of organic material in the soil. Both natural leaf fall and the foliage from prunings of the tea itself contribute substantial amounts, which may be of the order of several tons per acre annually (Eden, 1937; Goodchild & Foster-Barham, 1958; Visser, 1960). Accordingly the maintenance of a reasonable level of organic matter in the soil will depend very much on factors other than the presence or absence of shade trees, such as planting density, vigour of the bushes, manuring policy, pruning frequency and method, and plucking method. Since the contribution to organic matter by loppings from trees will also depend on many factors, such as tree species, lopping policy, and planting density, no general statement can be made regarding the relative contributions of the tea and the shade trees.

In those instances where the soil is properly covered by tea bushes, the question arises whether the mulch provided by the shade trees has any significant effect on tea production. Although no direct answer can be given to this question, some data derived from literature give an indication of the function of shade trees in this respect. At Kericho in East Africa, the effect of the removal of leaf droppings was investigated in a shaded experiment (Goodchild & Foster-Barham, 1958, 1959, 1960). It was found that the yield of plots (averaging 1,200 lb/acre), from which the leaf mulch was removed, decreased significantly, but the loss amounted to only 5% over a period of 3 years. At the same location, the influence of an added dosage of mulch was investigated in a factorial experiment on shaded tea (Eden, 1952, 1953,

1954) and in one on unshaded tea (Goodchild, 1955, 1956; Goodchild & Foster-Barham, 1957). A summary of the overall effects of mulch derived from the figures given, is presented in Table 5.

Table 5.—*The overall effect of the application of mulch at the rate of* 15 *tons per acre per year on the annual yield, in lb per acre (average of a* 4*-year pruning cycle), of shaded and unshaded tea*

	With mulch	Without mulch	Gain due to mulch
Shaded tea	1058	1052	+ 6(0.3%)
Unshaded tea	1226	1196	+30(2.5%)

It will be seen from Table 5 that the application of mulch over a 4-year pruning cycle had no appreciable effect on yield, irrespective of the presence or absence of shade trees.

Although the trials were not directly comparable and interactions with fertilizer applications and long-term effects have to be taken into account, it would seem from these three trials that in the case of tea which (judged by its yield) provided a good cover, shade trees did no provide much additional advantage as far as soil condition is concerned.

Apparently, the contribution made by the tea bushes themselves is the deciding factor, as can be seen from observations made by Dutta (1960). These showed that the continued removal of prunings from mature tea over a period of 8 years led to an average annual loss of 290 lb of made tea (25% loss) and a depression of the N-content of the soil. Figures given by Wight (1959) indicate that the presence of shade trees does little to counteract the yield decrease caused by removal of prunings. It appears, namely, that the removal of prunings over a 5-year period depressed the yield of shaded tea on an average by 34% and that of unshaded tea by 39%.

These losses are very high indeed and can be mainly attributed to the recurring lack of soil protection (annual pruning). This effect is aggravated by the practice of fish-leaf plucking in North India, which—though not immediately harming the bush—must mean that after the removal of prunings, the soil under the tea will have much less mulch from the tea itself (Visser, 1960) for a considerable period during the dry season. On many estates in Ceylon, where the pruning wood but not the twigs and foliage are removed by labourers, such removal is likely to affect yields much less when plucking cycles are reasonably long, when the bushes are single-leaf plucked for the greater part of their cycle, and when the tea provides a complete cover and is well manured.

In conclusion it can be said that the mulch provided by the shade trees is likely to have a favourable effect on the soil, but that the magnitude of such an effect will probably be small under conditions where the tea is generously manured, grows vigorously, and gives sufficient soil protection. On the other hand, where the cover provided by the tea is inadequate, shade trees constitute a definite advantage because of their direct and indirect beneficial influence on the soil.

2.4 The influence of shade trees on diseases and pests

Shade trees can influence the incidence of diseases and pests.

Well known is their indirect effect on Blister Blight. For instance, during the rainy season of 1958 it was found at St Coombs that the infection on an exposed unshaded field amounted on an average to 14% as compared with 42% on a sheltered shaded field (Visser, Shanmuganathan & Sabanayagam, 1961). The absence of shade trees would certainly reduce the incidence of Blister Blight and increase the effectiveness of a control system based on sunshine recordings.

More recently, indications have been obtained that *Albizzia moluccana* may be a source of the infestation of the tea by Shot-hole Borer, as it has been found that this beetle, which infests this tree species rather heavily in comparison with other trees (Judenko, 1960), can also breed in tea (Judenko, 1960a).

Shade trees that are infested by the same nematodes as tea might contribute to their spread. Fortunately, none of the more common shade-tree species appears to be a congenial host for Meadow Eelworm; the susceptibility of some, notably dadap, to Rootknot Eelworm is not such a danger, as this species affects only very young tea plants (Visser, 1959).

Mites on the other hand are often favoured by the absence of shade; and shade removal in the case of orange mite in Indonesia has been found to contribute significantly to the seriousness of mite attacks (De Weille, 1959).

These few examples may serve as a reminder that shade trees may be both disadvantageous and advantageous in connection with pests and diseases, though we do not know where the balance of advantage may lie.

3. The Effect of Weeds on Established Tea

On many estates in Ceylon, clean weeding is practised as a regular routine, mainly because it is feared that harmful species, particularly grasses, might become established, resulting in loss of crop.

Trials on the effects of various kinds of weeding on yields of tea have been done in India (Dutta, Basu & Sharma, 1959; Dutta *et al.* 1960), in Nyasaland (Anon., 1946, 1947, 1948, 1949, 1951, 1952, 1953, 1954, 1957) and in Ceylon (Eden, 1944, 1948; Portsmouth, 1952; Kehl & Piyasena, 1956). In cases where there is reason to believe that the soil was not thoroughly covered by the tea, weeding increased yield by over 30%, indicating that weeds could compete seriously with immature tea. With a good cover of tea, which depresses weed growth, differences between weeded and unweeded tea were much smaller and appeared to depend on the method of removal and disposal of the weeds. But the planting of Seychelles grass (*Panicum umbellaticum*) had an adverse effect (25%), probably because it grew well even in the shade of the tea. The adverse effects of root disturbance and of soil erosion, when weeding is done with a tool, may be almost as great as the adverse effects of weed competition, or at any rate, they complicate interpretation of the experiments.

4. The Effect of Bush Crops on Young Plants

Bush crops are often planted in young tea in order to provide both shade and loppings for thatching. It will be useful to consider, on the strength of the known facts, whether this is a good practice or a bad one.

Of interest in this connection is a trial carried out at Bvumbwe in Nyasaland on young coffee (planted in 1953) and which comprised 4 treatments: (*a*) no shade

and mulched with grass; (*b*) interplanted with *Sesbania punctata* (18 ft. square) with mulch; (*c*) coffee grown under tall bananas; and (*d*) *Sesbania* without mulch. The *Sesbania* and bananas were removed in 1956 and 1957 respectively and replaced by shade trees and mulch (Anon., 1955a, 1956a, 1957a, 1958, 1959a, 1960a).

TABLE 6.—*The effect of mulching and bush crops on growth, soil moisture status, and annual yield of young coffee in lb per acre (average of 3 years cropping)*

1	2	3	4	5
Treatments 1953/55	Treatments 1956/59	Girth '55 in cm.	Moisture '55 in %	Yield 1957/59
Mulch, no shade	Same	2.65	16.5	1176
Sesbania & mulch	*Albizzia* & mulch	1.64	13.9	504
Bananas, mulch of stems	*Grevillea* & mulch	1.85	10.0	347
Sesbania, no mulch	*Albizzia* & mulch	1.56	8.6	336

The outcome of this trial, presented in Table 6, clearly shows the marked detrimental effect of *Sesbania* and of bananas on tree growth (column 3). This effect, as judged by the yields (column 5) persisted after these plants were removed and replaced by shade trees and the soil was mulched. The depressed yield was not due to subsequent planting of shade trees, because in a parallel trial (Anon., 1960a) in which coffee was directly planted under *Albizzia*, differences between unshaded and shaded plots were negligible. As there were no significant interactions between treatments and manuring during the early years, it is evident that the set-back in tree growth had been mainly due to the adverse effect of the original crops on soil moisture availability (column 4).

Trials were also carried out in Nyasaland on the effect of different treatments on the establishment of young tea in the field. Comparisons were made between the performance of young plants protected by open-collared earthenware pots and shaded by *Tephrosia vogelii*, with and without a starter fertilizer (Anon., 1955, 1956, 1957). These trials were done at two locations and in three successive years; they showed that the number of deaths recorded a year after planting was on the average nearly twice as high under *Tephrosia* as with the plants protected by pots, namely 28.6 versus 15.6%; prunings obtained from the surviving plants 12 to 16 months after planting averaged 218 and 745 lb respectively.

TABLE 7.—*The effects of shade and starter fertilizer* (1 *oz at planting*) *on the prunings of young tea plants, in lb fresh weight*

Treatment	Without fertilizer	With fertilizer	Increase due to manuring
Protected by pots	389	699	310 (80%)
Shaded by *Tephrosia*	215	329	114 (50%)

It is evident both from the quoted figures and from Table 7 that *Tephrosia*, compared with the plants sheltered by open pots, had a markedly detrimental effect

on survival and growth of the young plants. The bush crop also depressed the effect of the starter fertiliser.

Results similar to those obtained in Nyasaland were found in a trial carried out in Ceylon by Kehl (Visser, 1960) on the effects of *Crotalaria anagyroides and Stylosanthus gracilis* on young tea.

TABLE 8.—*The influence of cover and bush crops on the survival and growth of young tea plants one year after planting (from Visser,* 1960)

TREATMENTS	% dead	Average girth in cm.	Mean no. of leaves per plant
(*a*) No shade	12.5	1.29	222
(*b*) Fern	0	1.52	285
(*c*) *Crotalaria* in alternate rows—lopped ...	17.5	1.03	154
(*d*) *Crotalaria* in both rows—lopped	3.0	1.05	188
(*e*) *Crotalaria* in alternate rows—unlopped ...	37.5	1.04	147
(*f*) *Stylosanthus* in alternate rows	35.0	0.82	83
(*g*) *Stylosanthus* in both rows...	52.0	0.69	55
(*h*) *Stylosanthus* and *Crotalaria* in alternate rows ...	37.5	0.85	87

It can be seen from Table 8 that, as in Nyasaland, the best results were obtained in the absence of a cover crop with no shade at all, or better still, with plants protected by fern. *Crotalaria* in alternate rows or in both rows, whether lopped or not (loppings used as thatch), depressed growth; *Stylosanthus* was even more detrimental. Presumably, *Stylosanthus*—though lopped around the plants—is particularly harmful as it depletes soil moisture. Determinations in Nyasaland in pruned tea showed that the soil with *Stylosanthus* as a cover crop started to dry out two months earlier and stayed near the wilting point for one to two months longer than clean-weeded soil (Anon., 1959).

Thus the use of cover and bush crops for the establishment of young plants in the field cannot be recommended. The best results are obtainable by thatching the soil and lightly shading the plants with fern, pots, or baskets.

5. Summary and Conclusions

A review of the effects of shade trees, weeds, and bush crops, on soil moisture and nutrient relations and the performance of tea has led to the following observations.

(1) It is improbable that shade trees assist in conserving soil moisture; they are more likely to compete for it. The degree of competition depends on the species, age, and spacing of the trees and can be greatly reduced by lopping. But lopping removes the shade.

(2) Shade trees are not likely to play a significant part in the root penetration of tea planted in forest clearings, nor is it certain that they would be of greater importance in that respect under different conditions of land.

(3) It is not proven that shade trees substantially assist tea in providing it with nutrients which it cannot obtain for itself; the effective root depths of tea may not differ greatly from those of trees.

(4) Competition for nutrients between shade trees and the tea occur. Although much of the nutrient is returned to the soil by the shade trees, some (especially potash) is locked up and removed in the timber. The amounts of nutrients returned to the soil as organic material by the tea itself are of the same order as those returned by foliage of shade trees.

(5) Estimates of the returns and losses of nutrients in tea which is inter-planted with shade trees suggest that the quantity of fertilisers applied at the 8 lb ratio may be deficient for potash, near-marginal for nitrogen, and ample for phosphate.

(6) Some leguminous plants fix atmospheric nitrogen, which subsequently becomes available to surrounding plants, especially through leaf fall. But the richer the soil already is in nitrogen, the less active this nitrogen fixation process becomes. Nevertheless some fixation still occurs in soil that is well supplied with inorganic nitrogen.

(7) There are indications that shade trees are not essential to maintain soil fertility under a good stand of tea. Soil fertility would seem to depend mainly on manuring rates and the condition of the tea itself, especially with regard to the direct soil cover it provides and the contribution it makes to mulch in terms of leaf fall and prunings. The presence of shade trees is desirable if the tea provides an unsatisfactory cover and if soil fertility is low.

(8) The presence of shade trees effects the incidence of diseases and pest, in certain instances favourably, in others adversely.

(9) The presence of weeds in mature tea can significantly reduce yield, but losses in crop may be small or negligible, provided the tea covers the soil well and outstandingly obnoxious weeds are kept out; under such conditions undue cultivation may do more harm than good. On steep slopes or in a poor stand of tea, weeds are to be preferred to soil erosion.

(10) Cover and bush crops in young tea are detrimental and therefore not to be recommended. Thatching of the bare soil should be a standard practice in order to reduce soil exposure and loss of moisture to a minimum; light shading of the plants in the early stages is also commendable.

(11) More scientific data are needed on the root growth of tea and shade trees, on the nutrient balance of inter-planted tea, and on soil moisture and organic matter relations.

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Question—Anon.

In very poor areas subject to recurrent drought would you recommend the planting of shade trees such as *Grevillea*, *Albizzia*, dadap and *Gliricidia*?

Dr Joachim: Dr Visser may not recommend such shade trees in these circumstances, but personally I would do so. Where the shade trees are rather dense, particularly with medium shade, it is better not to lop all of them at one time, but to lop alternate trees in the area and leave the loppings as a mulch.

Dr Visser: As has already been pointed out, Dr Joachim and I have deliberately arranged to give different points of view, to show how confused the position is and how uncertain is our information about shade. But Superintendents have to make practical decisions—to do nothing is still effectively the result of a decision—and so our different opinions may help them. Our intention has not been this, however, but to stimulate re-thinking, discussion and experiment. I do not want at this stage to discuss poor areas, areas with low soil fertility, because I shall deal with that in my next paper. But I can express an opinion on shade in very young tea. I would not plant shade trees but I would thatch the ground, and if I could, I would give temporary, non-rooted, shade to my young plants with fern or baskets. Mr Nelson Parker told me of a cheap and effective method: after having taken out the Guatemala grass, you then put up a few stalks of the grass over the plant to break the wind.

Question—Mr G. H. Hartley, Morratenne, Mawatagama.

Dr Haworth once suggested as a private opinion, that it would be better to remove all shade trees, and instead uproot 10 to 20 rows of tea per 100 rows, and plant this area up in Guatemala grass, using this as a thatch. Do Drs Visser and Joachim agree with this?

Dr Visser: If we could sell Guatemala grass as well as we can sell tea, it would be an excellent proposition. If thatch is badly needed then it would be better to uproot patches of the worst tea, for example eelworm patches, rather than uproot at regular intervals irrespective of the health of the bushes. But both tea and

Guatemala grass must be competing with the neighbouring tea for water and nutrients. There are cases in which interplanting might pay, but it would be most unwise to put forward a general rule for all circumstances.

Question—Mr C. B. Perera, S.D., Mahacoodagalla Estate.

(1) Is not the ultimate quantity of nitrogen in organic matter derived from the decomposition of woody material greater than the nitrogen used by such woody material in the process of decomposition?

(2) If it is, is it not advisable to fork in prunings?

Dr Joachim: I think Dr Eden did some work on St Coombs some years ago, and in some instances there was a loss, and in other instances there was a gain of nitrogen. When the material has totally decomposed there will be a gain. But during the process of decay there may be a severe drain on nitrogen in the soil, a severe shortage for roots in the neighbourhood, such as you get with any undecomposed organic matter in quantity.

Question—Mr Burroughs, Dyraaba Estate.

In areas affected by frequent drought and wind, casualties and damage are often attributed to scorch. Would Dr Visser advocate the maintenance of medium shade and wind breaks planted in tea in such areas?

Question—Mr Victor Ratnayake, Deniyaya.

If you were to recommend total removal of shade, would there not be a loss of crop due to heavy seasonal wind damage?

Dr Visser: I would first ask what is sun scorch due to? I strongly suspect that it is not simply due to heating up by the sun, uncomplicated by anything else. For example, the soil may be depleted of water by numbers of shade trees which are sufficient to do this but insufficient to give shade to certain of the bushes; wilting may then occur prematurely and perhaps wilted leaves will scorch more readily. But it is a well-known fact that certain deficiencies in manuring show up when the bush is under stress—especially shortage of water. It is also known that unshaded tea requires more nitrogen applied as fertiliser. It is thus possible that so-called sun scorch is partly due to lack of manure.

I cannot say much about sun scorch of bark. But if there is such an uncomplicated effect of the sun on pruned wood, it is a little surprising to see dry-season pruning of the tea accompanied by total lopping of the shade trees. Do estates that follow this practice get a lot of scorch? Or is it only when there are other deficiencies that even bark scorch occurs?

As for wind, does the regularly planted shade that is so common act as an effective wind break? Or would belts of trees—such as you see in Nuwara Eliya—break the wind more effectively, without competing with so many of the tea bushes?

Question—Mr K. D. Seelanatha, Matale West Estate.

Is inoculation of soils around leguminous shade trees with *Azotobacter* likely to increase nodulation?

Dr Joachim: As Dr Visser said, and I said, we do not yet know what useful function a leguminous plant plays in respect of nitrogen fixation under our acid-soil and high manuring conditions. Whether inoculation of soil with the necessary bacteria, as practised in temperate countries, would be beneficial or not we cannot say. That is one reason why I suggested in my talk that the appointment of a micro-biologist who would study these matters would be very advantageous.

Question—Mr C. B. Perera, S.D., Mahacoodagalla Estate.

Quite apart from the merits and demerits of forking in prunings, is it not beneficial to leave behind prunings in the field? As prunings are inevitably removed by labour for domestic use, is it not advisable to fork in prunings at least with a view to retaining the prunings in the field?

Dr Visser: It is quite clear that leaves of the prunings must be left amongst the tea. The wood of the prunings may be another matter, for it may be necessary for your labour to have it for fuel. But the prunings must be left until the leaves have dried and fallen off. In any case, forking in the wood of prunings on a healthy field in such a way that they cannot readily be pulled out, must cause quite a lot—possibly too much—disturbance to the tea roots.

Question—Mr Frank de Silva, Epalawa Estate, Kegalle.

Can wilting of tea be prevented during dry weather without high shade?

Director: There are two kinds of wilting of course: there is the temporary wilting which is the plant's form of protection against excessive water loss in times of shortage; and there is permanent, irreversible, wilting which results in the leaves dying. I don't know whether it would be a good thing to prevent wilting altogether. The question of protecting plants, tea plants, from wilting by using high shade is, to my mind, an unsettled one, for high shade is using water from the soil—water which should otherwise be available to the tea. Not only during the time of stress in very dry weather, but also in the dry period leading up to that dry weather, water is being taken up by the trees, and the time when permanent wilting may occur may be brought nearer by the trees in certain circumstances, and I think it remains to be determined exactly where the balance of advantage lies.

There is one thing which is becoming clear from work all over the world, arising from the work of Penman at Rothamsted, that if you have an acre which is completely covered by green vegetation, and if the soil has sufficient water in it, then the amount of water evaporated does not depend much, if at all, on the nature of the vegetation; that is to say, the shade trees do not save water, some of which will be lost from them instead of from the tea. Your trees are not economising water for you at all. Indeed, high shade forming a second layer of vegetation, might increase losses a little. If the tree roots do go deeper, they are perhaps taking water from the deeper layers, perhaps from the same layers as the tea; they may well be reducing the store of water which the tea could use and the time will then be nearer at which the leaves will wilt, heat up in the sunshine, and perhaps scorch. I do not know if our two experts—I am not an expert on this, of course—will think that there may be something in that—nothing for nothing, take what you want, but you will have to pay for it somehow.

While other questions are coming in, there is a remark which I would like to make. I want to draw a contrast between the work of Mr Foster-Barham and the discussions that we have been having, for example, about shade trees. Mr Foster-Barham has a most responsible advisory job which he discharges in a responsible

way; he realises that when he gives advice, people will usually take it. It is his job to see that no recommendation that is dangerous is made. When he is in doubt he says so. On the shade-tree question, however, we have introduced you to a controversial question that is under discussion, and we are not at present making recommendations except on the classical method, in which the judgement about shade trees is an art, and not a science. It is the art which is practised by Superintendents, Visiting Agents and, to some extent, by the T.R.I. So that distinction should be very clear. *Recommendations*, on the one hand, responsible and careful; and on the other hand *scientific discussion* of a subject which is in its infancy.

Mr Foster-Barham rather slurred over what seems to be an important fact about advisory work—the difference between an optimist and a pessimist is that the optimist says that the whisky bottle is half full, and pessimist says that it is half empty. Two-thirds of the estates of substantial size in this country have consulted the T.R.I. in the last few years. That I think is a very significant fact; it may also be of pessimistic significance that we haven't heard from the one-third of them for quite a long time.

Director: There are a number of questions about differences between the low-country and other parts of the island in respect of tea, with a long one here from Mr Frank de Silva of Epalawa, Kegalle, regarding shade. It is to be expected that in the low-country things will not be the same as in the high-country; more than that, they may vary as greatly in some respects within the low-country as they differ between low and high. One question is very much to the point: "Is it not likely that the problem is not so much shade or no shade as the correct control of shade?" No doubt that is the right question in many circumstances. Perhaps the most pertinent question at this time is this: Since Dr Visser quotes Tocklai in his tables, and we have here Mr Gokhale from Tocklai, is it not appropriate to ask Mr Gokhale to come and talk?

Mr Gokhale: Well, Gentlemen, when I was sent here, my Chairman told me to come and learn, and not to talk at all. However, since certain data from Tocklai have been quoted, I think I should clarify what we mean by shade, and the conditions under which the experiment is carried out at Tocklai are entirely different from what you are discussing here, and you should keep that in mind. Shade itself from sau trees, or similar trees that we use in North East India, does give us a response which is something of the order of that obtained from about 80 lb. of nitrogen. Actually we have figures from different experiments which range from about 30 and up to 90 or even 100 as Dr Visser said. That is quite true. In addition the kind of tea also makes a difference. You do not get response to nitrogen with all kinds of tea. Just as you are having a controversial conference here, we had one about ten years ago when Dr Wight propounded a theory that in the case of certain agrotypes the application of nitrogen does not pay at all under shade. I believe in that theory. The trouble is one does not know how to find out which kinds of tea do or do not respond. It is not so simple as that. The tea of commerce is a mixed hybrid, and to classify it under field conditions over six hundred thousand acres is not an easy thing at all. And in practice it is jolly difficult to tell in advance, or merely from paper records, whether or not a given section of tea will, or will not, respond to nitrogen under shade. The only way of course is to carry out a field trial. We are carrying out a large number of field trials, and I can assure you that, so far at least, I have not seen any instance where tea has not responded to nitrogen under shade. We are still searching for such areas, and I dare say we shall be able to save on our nitrogen in some manner, but at the moment our recommendation definitely is to apply nitrogen under shade, but of course lower doses

than we would apply either with no shade or with poorer shade. Dr Visser quotes data from two of my studies which suggests that the effect was only 5% of the soil nitrogen status. That is quite true. That result was obtained in Borbhetta Area 5. It is an experiment where half the plots are shaded and half the plots are not shaded. He also quotes data from some other trial which is totally unshaded and has been so for the last thirty years. Now the rate at which soil nitrogen drops there with time, which is rather a different thing, is quite staggering and in the case of the unmanured plots we found that the soil nitrogen had dropped by about 41% over a period of 26 years; but where fertiliser was applied—in this instance an N.P.K. mixture 2: 1: 1—the nitrogen loss was lower. That means the soil nitrogen benefitted by inorganic N.P.K. application, but if you look at the data carefully (I have the results of this which I shall hand over to Dr Visser) you will find that at the end of 15 years from this unshaded tea experiment the difference between the manured plots and the control plots is in agreement with a previous figure which is, namely, that shade increased soil nitrogen by about 5% at the end of 15 years in Area 5. In this Area 43, inorganic applications of N.P.K. mixture at the rate of approximately 60 lb. or thereabouts also increased soil nitrogen by about 5% at the end of 15 years. The point I am driving at is that shade does give you higher yield at very much lower cost under our conditions. Now, is it wise to forego that crop and would it pay more to spend money on fertilisers rather than on shade trees? Under our conditions we do not think so; but of course under your conditions it is a totally different matter and I would not like to express any opinion on that, and, I gather, neither does Dr Visser. It all boils down to this; you must carry out more trials. We will be very pleased to keep in touch with your work and will be most interested in it.

Director: I want to emphasise one point: what Mr Gokhale described as being good shade is where all the tea bushes are more or less equally shaded with the kind of reticulum of shade; in the high country of Ceylon that is very seldom the case. In many fields some of the tea bushes are not shaded at any time of the day, and in most fields most of the bushes are in full sunlight for a large part of the day. The dense shade often seen in the low country is hardly ever seen higher up. Assam is more like our low country and practises shading in a big way.

Dr Visser: Well, Gentlemen, I am glad that Mr Gokhale made the position of Tocklai very clear because, even if I have quoted the figures in a biased way, Mr Gokhale has been too polite to say so. We must say this: that we have to admit that we have no shade trials—it is not your fault and it is perhaps not our fault either—but it is a fact. Tocklai started thirty years ago with trials on shade trees and screens and they have amassed a large amount of information. We should now go ahead as fast as possible. After all we have doubled our yields in twenty years and wish to do so again.

Director: Mr Creighton says that the main effect of these papers and the discussions has been to make everybody completely confused and the lesson of that is that we want more experiments in various conditions in Ceylon. I think everybody will agree with that. There are, however, two remaining questions which I might combine to end the discussion. One is, does not removal of shade give increased yield on the short term? Is not the immediate effect of removing shade, without changing your manuring programme, to increase yields? The second question is: In a particular tea area due for uprooting, how soon before uprooting begins do you recommend the removal of shade *in toto*?

I think it is the general experience of planters who have removed shade completely either on fields, or on a whole estate that, for the first year or two in the up-country, and parts of the mid-country, there is a big rise in crop; in the third year the crop falls almost catastrophically below the original level. That is to say, if you

are going to uproot the tea for replanting, it is worth while not only doing slaughter plucking and getting extra crop from that, but also getting your shade trees out a year or two before the uprooting of the tea is to begin and get a little contribution towards your replanting. It must be recognised, of course, that the crop comes from somewhere. I suppose the decaying root systems of the trees provide the nutrients, and if we take them off in increased crop before uprooting, we shall have to re-supply as inorganic fertilisers during rehabilitation under grass.

HOW TO ECONOMISE ON BLISTER-BLIGHT CONTROL

THE DECISION TO SPRAY BASED ON SUNSHINE RECORDS

D. Mulder

Blister-blight control has gone on for over a decade on most estates and it is time to review the matter and set new aims for the future. The first impact of the disease was so alarming that most people involved were willing to sacrifice a lot of money, time, and effort, not to speak of shade trees, to save their bushes from death. Now we have come to live with Blister Blight and we should consider whether our control measures are up-to-date.

One relatively new possibility is the use of colloidal copper formulations. As early as 1953, colloidal copper was tried with good results in Southern India against Blister Blight (U.P.A.S.I., 1954). In Indonesia too, colloidal copper proved successful in the control of Blister Blight (Van der Knaap, 1956). The copper content of these products varies from 12 to 27%. So far, colloidal copper has not become particularly popular amongst planters in Ceylon. One of the reasons may be that this form of copper is less visible on the leaf than the oxide and oxychloride wettable powders. In the future this may be less of a disadvantage in connection with the use of mistblowers, because instead of spraying bushes individually a whole area of 6–10 rows is sprayed.

Another rather new group of fungicides contains a mixture of a copper compound and an organic zinc compound, namely Zineb (zinc ethylene-bisdithiocarbamate). These products have the same advantage of a lower copper content like the colloidal coppers, and, in addition to that, the advantage of adding zinc to the plant and the soil. These are the only interesting new possibilities in the field of fungicides.

The economy of spraying is very much linked with the time and the *method* of application. The time of application is, as a matter of fact, of the highest importance in connection with the efficiency of the whole control measure. Until recently the date on which to start spraying has been decided on in relation to the onset of the monsoon as the decisive factor. This implies that the amount of rainfall has been taken as the most important weather condition.

It has been shown by the work of Visser, Sabanayagam and Shanmuganathan (1958), based on earlier work done by Van der Knaap (1955, 1956) and de Weille (1956, 1957) in Indonesia, that not only rainfall but also sunshine decides the amount of Blister Blight you are going to have. This has led to the installation of thirty-seven sunshine recorders on various progressive estates (See Plate 1).

My main purpose at present is to help to further the cause of the sunshine recorders, so that you may get the most out of them. We have introduced the measurement of sunshine as a guide for blister-blight control because the ultraviolet rays of the sunlight kill the spores of the blister-blight fungus. The depressing effect of sunshine on the spread of the fungus has been shown to be greater than the promoting effect of rainfall. This is most probably due to the fact that it is not the rainfall in itself that is so important for blister-blight development, but the wetness or dryness of the leaf surface.

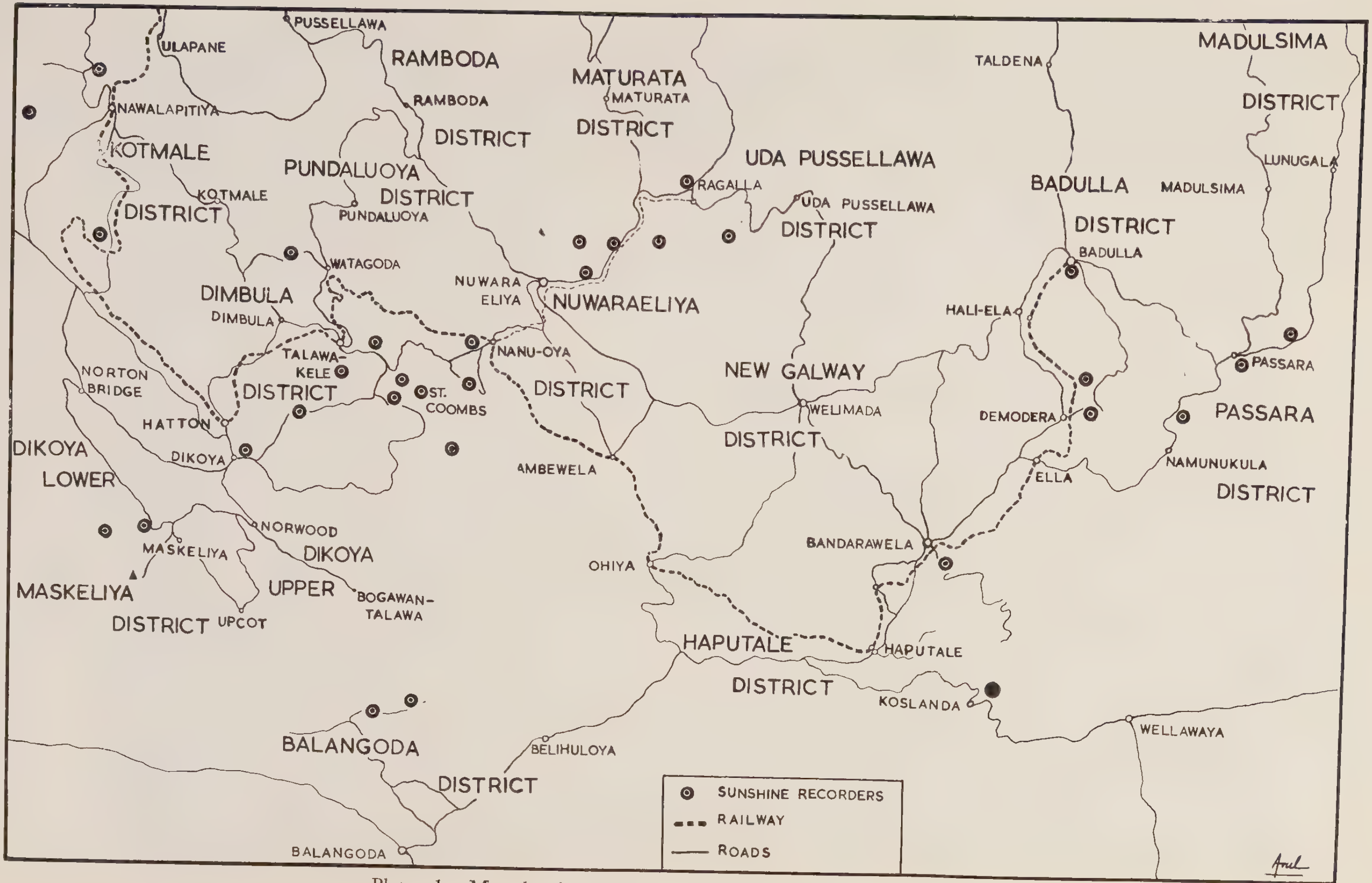

Plate 1. Map showing the location of sunshine recorders in Ceylon.

Plate 2. Sunshine recorder of the Campbell-Stokes type, mounted on a stone column and surrounded by a fence, at St Coombs Estate.

Leaf wetness is not governed by rainfall alone, but also by air humidity, air temperature and wind velocity. If the wetness were easy to measure, we would probably by now have a leaf-wetness recorder on every estate. This, however, is not so. Leaf wetness is hard to define and hard to measure. Therefore sunshine recording, which is very easy, has been developed into a good alternative (Plate 2).

A number of experiments have proved the practical value of sunshine records as a guide to help one to decide whether to spray or not to spray on a certain day.

The only trouble in the application of this timing scheme for blister-blight spraying is that inevitably, when one omits spraying rounds on the basis of sunshine records, one must counter-balance the greater risk one runs of future outbreaks by being able to spray big areas in a short time, *i.e.* in half the time that was available before. The practical reason is that a round is not really omitted, but only postponed for four or five days and might therefore coincide with the spraying of another part of the division. This theoretically necessitates the doubling of spraying gangs and spraying equipment. Such an emergency would not arise often and different estates have already managed to overcome this difficulty and have successfully applied the new system of timing blister-blight control. However, this emergency situation that might arise has no doubt frightened several planters and kept them from applying their sunshine records to the full advantage of reducing the number of spraying rounds. Here modern spraying equipment comes to our rescue. The recently introduced mist-blowers have saved the spray-timing system from the danger of remaining a mere hobby of scientists. Mist-blowers can do the work of spraying in much less than half the time and they are therefore the answer to this problem of how to double the acreage covered on a certain day.

Sunshine records can not only guide us in the decision of postponing spraying rounds to be carried out on days following a period of sufficient sunshine, but can be of even greater value in indicating the right dates for starting the spraying campaign and for ending it. It very often happens that Superintendents are, despite their long experience, taken by surprise by an early development of blisters and thus start spraying too late. If they had kept an eye on the sunshine records, they would have noticed that, although the rains had not properly started, sunshine hours had diminished to such an extent that spraying was indicated.

At the end of the monsoon, spraying has become part of the routine work and, as an insurance against an unexpected prolongation of the monsoon, blister-blight control is kept going, although a marked improvement in weather conditions has set in. This practice results in useless continuation of spraying which can be avoided by examination of the sunshine records.

TABLE 1.—*Number of spraying rounds that could have been saved if spraying had been done according to sunshine data*

ESTATE	No. of rounds sprayed	No. of rounds necessary. (calculated)	No. of rounds that could have been saved
JUNE–DEC. 1959			
St Coombs ...	26	16	10
Dessford ...	20	17	3
Meddecombra ...	19	15	4
Kirimetiya ...	17	6	11
JAN–DEC. 1960			
St Coombs ...	26	21	5
Court Lodge ...	32	25	7
Balangoda Group ...	22 or 18½	16 or 18	2 or 4
Galemudena ...	22	27	5
Cannavarella ...	25 (Dusting)	15	10
Dickwella ...	18 (Dusting)	18	0
Queenstown ...	10	8	2

The results obtained in 1959 at St Coombs Estate are further illustrated in Fig. 1.

Some Superintendents have enquired "To what acreage should the records of one sunshine recorder be applied"? The answer is that this naturally depends on the lie of the land and the climatic variations in the area concerned. On the average, each division should have its own recorder. It should be taken into account here that our minimum of 20 hours of sunshine over a period of 5 days has been worked out for average tea land including less-favourably situated slopes. On flat land, one could most probably do with much less than 20 hours.

In places, however, where one half of a division lies on the more sunny slopes towards Uva districts and the other half on misty slopes, exposed to the south-west monsoon, one should naturally not try to apply the same sunshine records taken on the sunny side to blister-blight timing in misty areas. This is a matter that has to be sorted out by each Superintendent for his own estate by trial and error. In this connection, it is of importance to mention the fact that an assessment of the amount of Blister Blight present on the third leaf in a certain field can easily be carried out by the estate staff (for instance a conductor) according to the method given in a leaflet of the T.R.I. Care should be taken not to judge the standards of blister-blight control by walking along the road, but by taking samples at random well inside the field.

Summarising, we can conclude that the future development of blister-blight spraying is directed towards:

(1) taking sunshine records for the timing of applications;

(2) using fungicides which contain less copper;

(3) using spraying equipment that can cover large areas in a shorter time with less liquid.

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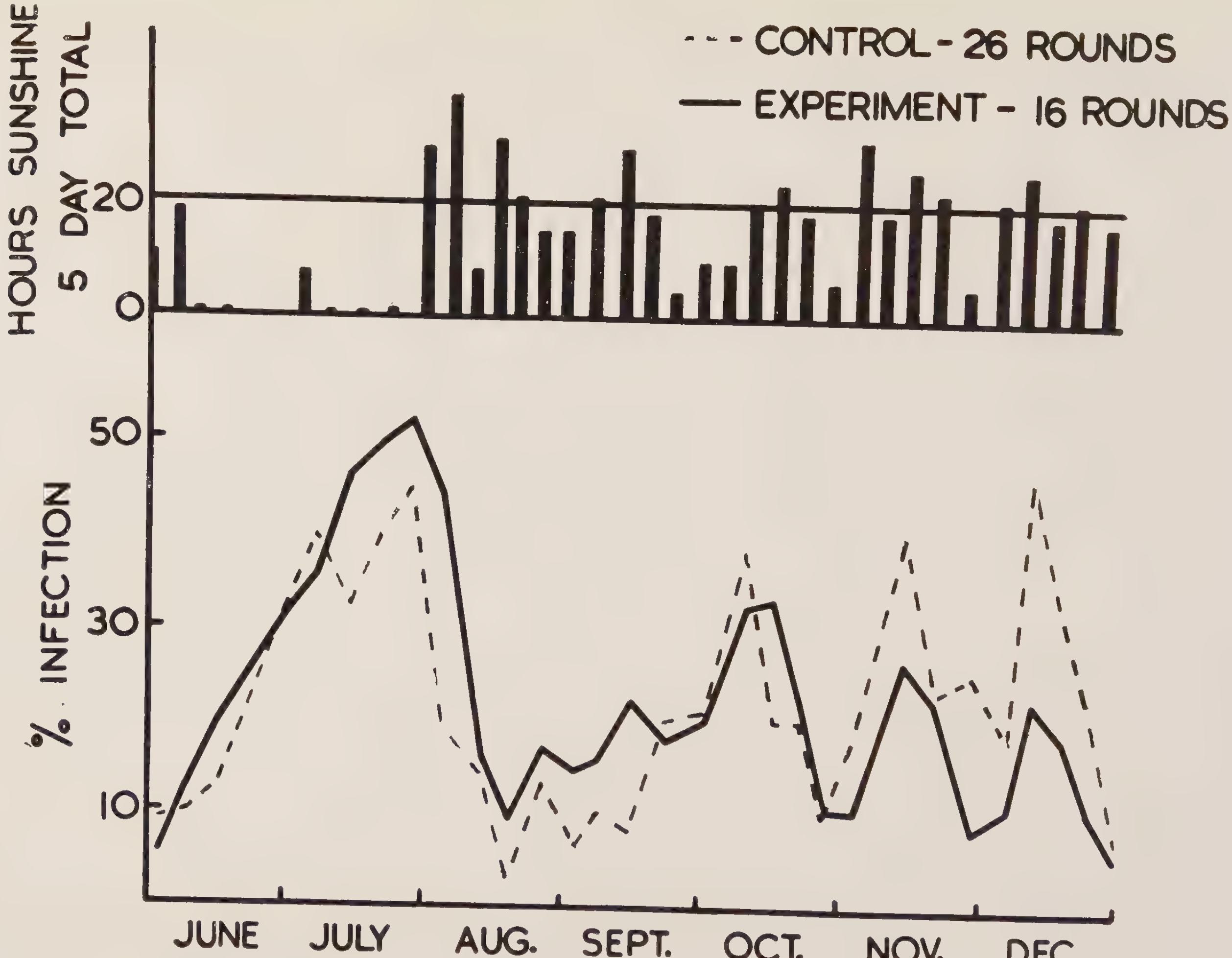

Fig. 1. Experiment on the timing of spraying against Blister Blight according to sunshine records, at St Coombs June-December, 1959.

HOW TO ECONOMISE ON BLISTER-BLIGHT CONTROL

THE USE OF MIST BLOWERS IN CONJUNCTION WITH SUNSHINE RECORDERS

A. L. Elias

In December's issue of the *Tea Quarterly* (Elias 1960), I gave some details on the use of mist blowers. Since then, work has been done to find out more about the cost of spraying per acre, the performance of these machines and the distribution of the spray on the foliage.

Dr Mulder, who has preceded me, has already pointed out the value of using mist blowers in conjuction with sunshine recorders. By timing the spraying rounds according to sunshine records, we can often economise on the number of sprayings required; by using mist blowers, we can not only achieve the more rapid coverage of large areas which is desired but can appreciably reduce the cost of labour per acre.

During the past few years, tens of thousands of shoulder-mounted motorised mist blowers of various makes have been sold all over the world. However, these machines are comparatively new in the field of spraying and dusting in Ceylon. The cost of one of these machines varies from Rs. 750/- to Rs. 950/- and the weight from 28 lb. empty to 56 lb. fully loaded. The sprayers are simple in design and easy to operate. The machine (Plate 1) consists essentially of a small two-stroke motor, driving a fan which produces a strong air-blast down the 'lance'. The spray liquid is fed from the liquid tank on top to a nozzle or jet in the end of the air lance. As with a paint-spray gun, the air blast breaks up the spray liquid into very fine droplets and also assists in carrying these to the 'target'. This is the principle of 'air-assisted' spraying. The droplet size is finer than that produced by ordinary knapsack sprayers and hence it is possible to obtain a good distribution of the spray on the foliage with much smaller volumes of spray liquid per acre.

Large-scale spraying against Blister Blight was carried out at St Coombs using several makes of mist blowers which were available on the market and were kindly lent to us by Colombo firms.

A mixture of 4 ozs of copper fungicide in two gallons of water per acre was found to be adequate and effective for protection against Blister Blight under adverse weather conditions, except for young tea and for tea recovering from pruning, where 6 ozs of copper fungicide per two gallons of water per acre was necessary.

For the same amount of copper fungicide per acre, protection was found to be at least as good in fields sprayed by mist blowers as in fields sprayed by conventional knapsack sprayers. Observations showed that there was extremely good distribution and that the fine droplets of spray from these machines were evenly spread over the flush and the upper surfaces of the mature leaves (Plate 2) for 3–5 rows on either side of the spraying labourer, *i.e.* 6 to 10 rows of tea at a single spraying, under favourable wind conditions. When winds were particularly strong there was some reduction of this area. The liquid is atomized and ejected with the aid of a strong

air current which reaches a velocity of over 200 miles per hour at the nozzle. The machines are used always at full throttle. Any lessening of engine revolutions below the maximum (which is governed) results in less air blast, resulting in less break-up of the spray liquid and less 'carry'.

A team of three labourers operating two mist blowers can spray 40 acres in a day with ease. Treatment is thus more rapid with consequent considerable saving in labour costs. To achieve this, however attention must be give to rapid refilling of the sprayers. Previously, I gave the figures of 10½ acres per day per machine (Elias, 1960); this was arrived at in the early stages of testing these machines, and in subsequent work, with better field organization, and slight modification of the machines (see below), much better results were achieved.

Naturally, the speed of operation will vary from estate to estate, due to terrain, height of the tea and other factors. The suggestions that follow may be helpful.

The aim is to apply the required dose of fungicide in about two gallons of water per acre. To achieve uniform spraying, the machine must give a suitable constant spray output, and the labourer must walk at a suitable constant speed, a speed at which he will cover the acre whilst spraying the two gallons. The time he takes to cover an acre will depend on his speed of walking, the number of rows he takes at a time, and the spacing between the rows. The labourer should have an easy pace so that he is able to maintain the same speed on the steepest ground as on easy terrain; he should be trained to do this. As an example from St Coombs, a labourer walking at a speed of about 30 yards per minute (which is nearly 1 mile per hour) and going down every tenth row (that is, spraying five rows on each side) will walk an acre in 10–12 minutes. Thus we need to arrange the output of our machine so that we spray two gallons of liquid, containing the 4–6 ozs of copper fungicide, in 10–12 minutes. Obviously, if the liquid output varies we cannot hope to achieve regular spraying. Many of these machines have variable dosage taps combined with the on-and-off tap on the lance; these are troublesome because, firstly, the labourer can alter it while spraying, and, secondly, we have found that they do not in fact give a constant output for the same setting. To our own machines we were able to fix a dosage restrictor jet in the liquid feed pipe; these are supplied in different sizes for some makes but could easily be made for any make. (Plate 3).

It is worth while if you start this spraying technique and have to train labour, to check the time of machine output regularly, and also the speed of walking. A stop watch is useful.

The actual working period per day was reduced to five hours. One labourer in the team mixed the fungicide, carried supplies of fuel and oil, and a tool kit to enable him to carry out minor running repairs. Contrary to expectations, labour reaction was favourable and there were no complaints about noise, vibration or excessive weight. Given an extra inducement, a pair of ear plugs and protective clothing, the labourer considered himself a specialist from the outset.

Spraying can be done for under Re. 1/- per acre. This includes the cost of labour for spraying with an extra rate of -/40 cts per day, cost of the fungicide at 4 ozs per acre, and the cost of petrol, oil, tea and protective clothing.

Serious consideration should be given to the use of mist blowers in the future in conjuction with sunshine recorders. Each machine is capable of spraying 120 acres in a 6-day week. Therefore large areas can be sprayed at any given time as soon as the hours of sunshine diminish.

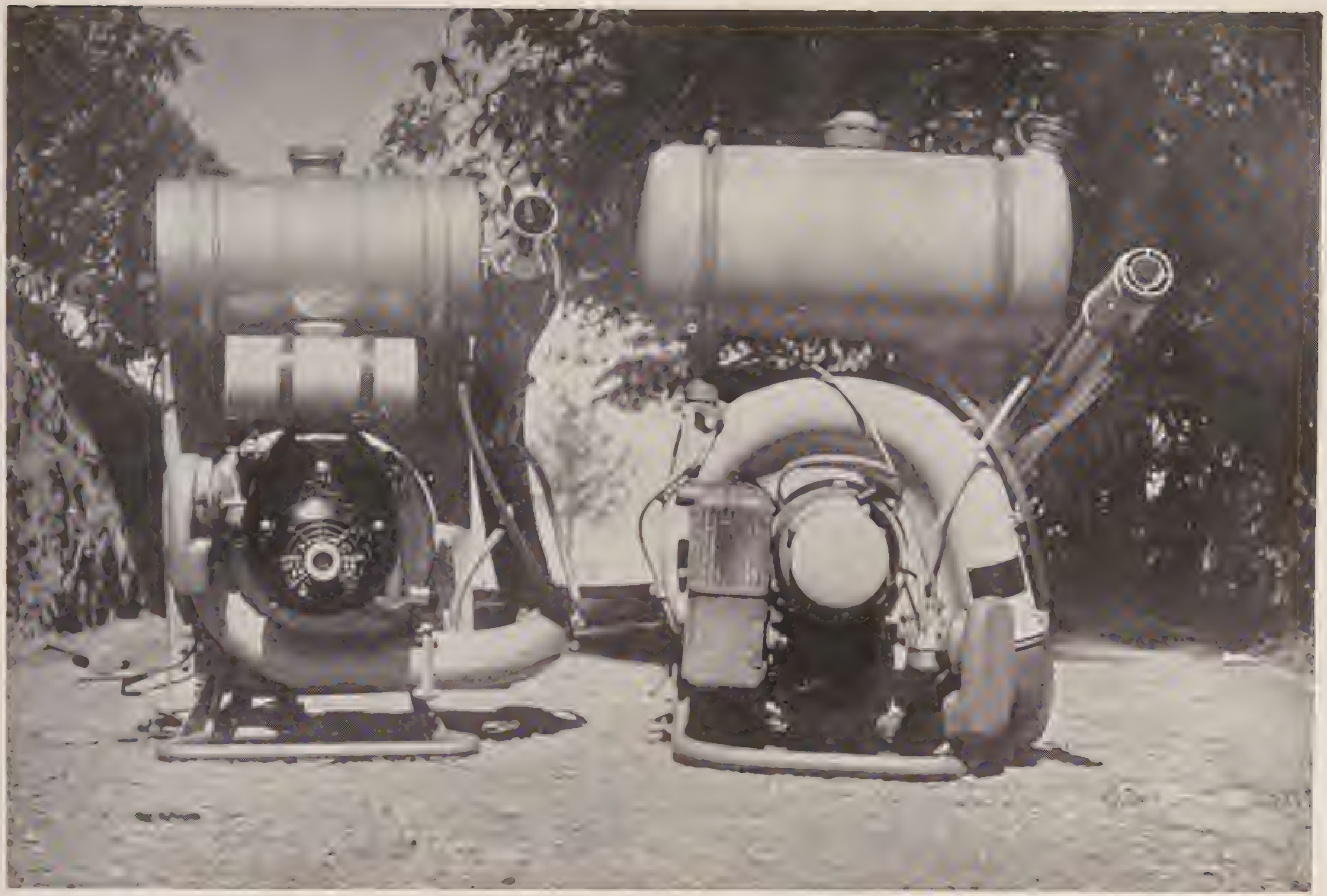

Plate 1. Two makes of motorised mistblowers, rear view.

Plate 2. Typical distribution of spray deposit from mistblower (left) and Knapsack sprayer (right). Note the larger droplets on the right shoot. The photograph is of a fluorescent dye at 4 oz. per acre, taken in u.v light.

Plate 3. Dosage restrictor jets of different sizes, showing how they fit in the on-and-off tap of a mistblower.

Finally, I would also mention colloidal copper formulations which, because of the extrme fineness of the particle size and good suspension properties, are very suitable for use in mist blowers. The formulation tried out at St Coombs contains 27% actual copper, as compared with the usual 50% wettable powders, and is used at the same 4–6 oz. per acre; copper residues in the made tea are therefore less and can more easily be kept below the tolerance level of 150 ppm.

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Question—Mr K. D. Seelanatha, Matale West Estate.

The spores of *Exobasidium vexans* (Blister Blight) are known to be carried and brought in by mist and cloud during certain monsoons in different areas. Is it not possible to control Blister Blight on a district scale by means of aerial spraying of the incoming clouds en route? Is not this method likely to be more economical, and the advantages widespread? If this approach has not been investigated is there a likelihood of it being done in the near future?

Dr Mulder: When the Blister Blight fungus first came to Ceylon it most probably came in the way described by the questioner, namely over a long distance through the air in the form of spores protected against sunlight and dryness by high humidity in a cloud. Nowadays the fungus is present almost everywhere tea is grown in Ceylon and long distance travelling is no more essential for its spread and occurrence.

Therefore there is no purpose in "aerial spraying".

Question—Superintendent, New Peacock Group.

Am I to understand from Mr Elias's talk that the savings in costs are only or mainly in respect of labour costs? If so, is there any point, particularly with increasing populations on estates, in substituting machines for men if the operation is carried out equally effectively?

Dr Mulder: You can spray an acre with a mistblower so much more quickly and with so much less effort that you can use the sunshine method and increase the number of acres that can be sprayed in a day.

Question—Mr Victor Ratnayake, Deniyaya.

Is the cost per acre for one spraying or for a number? Please give cost per acre per spraying.

Director: The figure was one rupee *per spraying* per acre; compared with the normal method of spraying most people will find that one rupee gave quite a good saving.

Question—Superintendent, Hindagalla, Namunukula.

The stated cost of spraying at approx. Re. 1/- per acre does not presumably take into account the short life of the equipment. A machine costing about Rs. 1,000/- is said to have a life of 5,000 acres, *i.e.* about -/20 cents per acre. Including equipment, the total is thus about Rs. 1/25 per acre.

Mr Elias: We assume that the life of a machine is 2 years. The price of these machines varies from Rs. 850/- to Rs. 950/-. On the basis of 24 days spraying per month and a minimum of 6 months spraying per annum, the cost on capital outlay is -/16 to -/17 cts per acre, which is less than the questioner suggested.

Question—Superintendent, Forres.

What servicing facilities are available for mist blowers?

Mr Elias: Messrs Shaw Wallace & Hedges Ltd., of Colombo have facilities for carrying out decarbonization and this is done free once a year. Also their mobile workshop will visit estates once a year and carry out all repairs. They carry all spares necessary. The training of operators free of charge will be done in Colombo. I understand that other firms in Colombo intend to have similar facilities.

PLANTERS QUESTIONS

Question—Superintendent, Marysland, Nakiadeniya.

Rainfall is considered to be important for producing high yields for the low country. Would the introduction of artificial rain-makers, sprinklers, mobile units and such like which are on the market be economical and increase yields appreciably?

Dr Joachim: I cannot answer that question. Dr Ananda Rau might be able to say something about South India, where, I understand, some work has been done in that direction.

Dr Ananda Rau: What we have been able to do in South India has only been on a very limited scale. There have been a few estates that have taken up overhead irrigation in a limited way, mainly to get an increased production during the dry months or quality periods and at the same time to see if that works as a palliative. I do have not good figures on this subject, but the indications are that it is quite possible to increase yields by about 15%. But there is not enough water to do it on a big scale. You may appreciate that to irrigate an acre of tea, something like 22,000 gallons of water are needed and, according to our calculations, tea transpires water to the extent of about three inches of water per month. In order to be able to compensate or make good the loss of three inches we have to apply at least four inches of water and that would cost quite a lot. That is about all that I can say. There are indications that with overhead irrigation there is a possibility of controlling mites to some extent, or, at least of checking their build-up.

Question—K. D. Seelanatha, Matale West Estate.

1. Layering or bending of a clone like 777 and 1294, which I have observed to be flowering, does appear to increase this tendency. Is this a general aspect? If it is so, is it not advisable to use the knife on such flowering types rather than resort to layering?

2. Mr Elias mentioned that clone 777 is an upright grower. My observation is that it is a natural spreader.

Mr Elias: The answer to the first question is that we do not know. As regards Clone 777 being an upright grower, the comparison is made with clones of the T.R.I. 20 series which are exceptional spreaders. One cannot call 777 a natural spreader in that sense of the word.

Question—Mr V. Ratnayake, Deniyaya.

What effect has shade on the quality of tea? (Similar questions were raised by Messrs F. M. C. Thomas, J. A. Cameron and the Superintendent of Hellbodde Estate).

Mr Keegel: Before I proceed to answer this question and the others on the same subject, I might as well define quality. Used in its broadest sense it refers to all the desirable characteristics of a tea, but as it is generally known in this country it has a specific reference to high-grown quality.

It must be regretfully admitted that we have not carried out any tests on the effect of shade on high-grown quality. But from my observations on visits to various estates, it would appear that shade is not favourable. In that connection I might mention that Tocklai itself has made the same observations, although Dr Visser in his remarks on shade did refer to the fact that there was no difference in the price of tea made from shaded and unshaded areas. Now in the work conducted at St Coombs over the past many years, there is not the slightest doubt that colour is improved at the expense of quality, which probably explains why Assam did not find any difference in the prices of made tea from these experiments; a premium is paid for teas with good colour in that part of the world.

On the effect of shade on quality in mid and low-grown teas, all I can say is that, since there is not much quality to speak of in such teas, shade might influence colour.

Apart from these considerations I am also inclined to think that, as a personal opinion, if shade is to be beneficial at all to any high-grown estate it would be with respect to a low jat bush and not a high jat one. One frequent complaint about up-country teas is that they lack colour, and it is probable that because of the nature of low jat bushes, which are generally common in the high-grown areas, sufficient colour is not being obtained owing to little shade. Such bushes would probably benefit from more shade, whilst high jat bushes would not need as much to bring about a significant improvement in colour.

Talking of shade, I might refer to another point, and that is with respect to the appearance of a low-country tea. We all know that the value of a low-country tea is enhanced by the prevalence of tip. Now tip, you will agree, is the result of a morphological character and can be influenced by shade. It is a matter that really concerns other Divisions, but it will not be lost sight of once we have our low country sub-station.

The fact that shade has an influence on the character of tea is without question. In Japan, for example, they have found that the absence or presence of shade has an important influence on the properties of green tea and even their semi-fermented teas.

In reply to a question from Mr Thomas on the influence of shade on stalk, it is reasonable to expect less stalk and fibre under conditions of heavy shade because the inter-nodal stem, though longer, would be more sappy than what it would be under no shade.

Question—Mr Frank L. de Silva, Epalawa Estate, Kegalle.

What would be the advantages if nylon tats are used for withering in place of jute hessian?

Mr Keegel: One of the advantages of using nylon for withering is of course that it has superior wearing properties. Another is that it does not sag, as a result of which you are bound to get a more even wither. The third advantage is of course that you can spread much thicker than on an ordinary hessian tat. But to gain that full advantage of being able to spread more leaf on nylon tats one important

consideration is the size of the perforation. In the tests that we have conducted at St Coombs over the past 10 years we find that Tygan mesh, for example, which has 14 perforations to the inch, has not been found to be very much superior to hessian. Whereas a more recently imported type, like the Japanese fishing net, with only 4 perforations to the inch has given much better results. From the results of the preliminary tests conducted so far, you could spread leaf at the rate of 1 lb. to 7 sq. ft. on nylon net and get the same wither in the same time as from hessian with the usual spread.

Question—Mr Frank L. de Silva.

As low-country teas are valued for appearance and the wire meshes cause a certain amount of greying in tea, would it not be possible to prevent discolouration by using meshes made out of smooth material such as plastic?

Mr Keegel: I suppose you will reduce greying of teas by the use of plastic mesh, but you will have to consider the guage of nylon used for sifting purposes. If you don't have the right guage, you won't get the right type of tea, and if you will examine nylon very carefully you will see that for the same size of guage and same size of perforation, the difference between wire and nylon mesh is very small indeed. If one is to reduce greying with the object of improving appearance, stamped aluminium is the answer.

Question—Superintendent, Hellbodde Estate.

Does increased application of nitrogen have an adverse effect on quality?

Mr Keegel: According to recent work carried out, where applications up to 80 lb. of nitrogen were tested, a slight loss in quality was observed, but not appreciable enough to be of commercial importance. I regret we have no evidence on higher applications, but Tocklai reports that quality is adversely affected. I should like to add that from the little I know of Assam quality, the type of quality we refer to in Ceylon is something entirely different from that which is associated with an Assam Tea (*Mr Gokhale agreed*).

Question—Anon.

What are the visible symptoms of potash deficiency?

Mr Tolhurst: The best way I can describe the most typical symtoms of potash deficiency is that the leaf appears as if someone had gone round the edge of it with a cigarette-lighter. There is a rim around the leaf completely dead—sometimes light grey, sometimes light brown. There are one or two other symptoms of potash deficiency which occur on individual bushes, but I would not attempt to describe these at the moment. The most common symptoms are illustrated in the *Tea Quarterly* for December 1953, and there will be some more photographs in a little while—the whole range.

A more suitable name for the common potash deficiency may be "potash scorch". If shoots are growing freely, the symptoms show up worst on the lower leaves but, if shoots are in plucking, the symptoms may appear as high up as the mature leaves in the plucking table.

Director: I suggest that since Mr Gokhale has come from Tocklai, he might be able to say a few words about urea, which I understand has been used in Tocklai as a source of nitrogen.

Mr Gokhale: Mr Chairman and Gentlemen, first of all I would like to express on behalf of the Indian Tea Association (Scientific Department) our sincere thanks for the very kind invitation we have received from the T.R.I. of Ceylon and for your generous hospitality. I have listened with interest to various addresses and I would like to take the subject of urea first. I was most surprised when Mr Tolhurst spoke about potash-deficiency symptoms and manganese toxicity and so on when you are already applying potash to the tea. In North East India we do not apply any potash at all to our mature tea and yet I have not seen any potash deficiency at all!

Now it has been suggested that continual use of ammonium sulphate cannot be a good thing and we are also alive to that question, and we are looking at it very carefully. We are not of course using very high rates like 200 lb. of nitrogen or half a ton of sulphate of ammonia. The reason is that we have already found that as soon as we go beyond a certain limit, say, for argument, 100 or 120 lb., there is an appreciable drop in quality of the tea, and we dare not risk our tea being sold at 6d. a lb. We are of course trying out all makes and different types of nitrogenous fertilizers, and urea is one of them. We are trying out all possible nitrogenous fertilizers that are on the market. Urea will be manufactured in India in large quantities, and we have about a dozen trials in different parts of North East India, where urea is being compared with ammonium sulphate, ammonium chloride, and various other things. These trials have not gone on for a very long yet, but all of them show that urea is not as efficient as ammonium sulphate. We have given a tentative rating of about 90% efficiency to urea, but I am seriously considering that it might be reduced to about 75% or possibly even lower. It is cheaper at the moment on a unit nitrogen basis, but not if it is only 75% efficient. How much ammonium sulphate can be used continuously remains to be seen, and as I said earlier, we are studying this very carefully, but we are quite happy to carry on with it, and if you people stop using ammonium sulphate, we will get some more.

Just one or two points about shade. You have been listening to Dr Visser's and Dr Joachim's addresses and perhaps you have been confused in not being able to understand some of the statements. I myself could not understand quite a bit of it, but that is because I do not know your conditions. I think it is possible that both are right. All I can say as far as North East India is concerned—and remember that 93% of my area is below 1,000 feet elevation and Tocklai itself is at an elevation of 286 feet above sea level—is that in Assam the sun is an enemy, not a friend. Darjeeling is of course different, but that is only a very small percentage of our area. Secondly, when we talk of *shade*, it is better to be precise in what you mean by the word. I have seen some of your shaded areas and found them not shaded at all! What I am trying to say is that the type of shade that you use and the method of growing a plant are not at all the same as in North East India. The nature of the shade trees, the shape of the leaves, and so on are totally different, and what we mean by shade in the plains of North East India is that we have more or less a complete canopy at something between 25 and 50 ft. over the whole of tea; and the shade thereby allows a pattern of filtered light over the tea bushes. Now I did not see very much of this in Ceylon, but I do admit that I have been here for three or four days only. In the last analysis, whether or not you should have shade or whether you should manure or should not manure with urea or ammonium sulphate and so on, depends on the economics of it. In fact we ask ourselves that question and that question alone!

The question has been asked: Does tea plus shade remove more moisture than only unshaded tea? We have no time for questions like that. The only question we ask is: Does the shade tree benefit the trade or is the Tea Company going to benefit? That is all we want to know. All our experiments have definitely shown that in our conditions our kind of shade is economical. There is no

question of it. It is outstanding economics. To us a shade tree is worth at least 80 lb. of nitrogen which is about Rs. 80/- per acre. As a rule it costs us Re. 1/- or two to put it there.

Urea, I am afraid, in addition to lower nitrogen efficiency, has certain other disadvantages also. I do not know what Ceylon conditions are, but in North East India I have seen urea, ammonium sulphate nitrate, and Chilean nitrate and so on. One Manager sent me samples saying: What is this mixture of oil I have received from a certain firm? And it was nothing but ammonium sulphate nitrate which had picked up moisture. Any material that arrives in that condition just cannot be applied uniformly by hand throughout the whole area. We have always been prepared to pay more if we can be guaranteed that the condition of the manure will be free-flowing. To me this is quite an important point. Considered from that point, I don't think that urea is going to be a very promising fertilizer for North-east Indian tea areas, but if you find it better, you should switch to it. But before you do so, carry out a number of field trials and I would not advise you to assume that it would be as good as ammonium sulphate, because not only for us, but also in East Africa, it is not as efficient as ammonium sulphate and you should know what its efficiency is under your conditions and take that into account in your calculations.

Director: I think that shows the great value of getting experts from other places. I thought the last Tocklai Annual Report indicated that urea had no manurial effect—no nitrogen effect at all. Well, now we learn that it has some effect and we have had a number of other penetrating remarks by Mr Gokhale, which have been carefully noted.

People have begun thinking afresh about the subject of shade and I gather from talks during the tea interval that some people are thinking of taking action. Let us be quite clear that the T.R.I. is *not making any recommendation* at the moment to change the shade conditions. There is no recommendation. Go on doing what you are doing until somebody has had a good look at it and found that it is not right under the present artistic conditions; no change please.

LETTERS TO THE EDITOR

WEDGE-PRUNING

For some time, I have considered that, given adequate cultivation, the older tea in the island could give considerably higher yields if there were a sufficient number of plucking points. Assuming a full cover of tea, so that it is no longer possible to go 'sideways' to increase the area of the plucking table, an increased area can be produced only by going upwards in the form of a 'wedge' along each row. It was felt that with the normal system there was insufficient mature foliage to keep the bush really healthy on a yield above, say, 1,700 lb. per acre; wedge-pruning and plucking should provide more maintenance foliage. This method might also give the maximum benefit from high-yielding clonal material. It was envisaged that each bush would ultimately be five feet high in the middle of the row, being plucked from ground to top; this would give a plucking table with an area four times greater than is possible with the normal system.

Oddington No. 5 Field

Experiments were first started in this field in December 1958. In all these experiments, the worst parts of the fields were used for the experimental pruning. There were three plots as follows:—

Plot No 1 (4 acres), given a normal clean prune;
Plot No. 2 (2 acres), wedge-pruned and the top of the bush lightly skiffed only. This plot was plucked straight in;
Plot No. 3 (2 acres), wedge-pruned as No. 2, but tipped and brought into production.

The crop figures are given in Table 1. From the weights of green leaf recorded, I have calculated the yields of made tea in lbs per acre at a 23% outturn.

TABLE 1.—(*Oddington No. 5 Field*)

	Made tea (lbs per acre)		
	Plot 1 (Normal)	Plot 2 (Wedge)	Plot 3 (Wedge)
1959 April	48	41	17
May	18	176	189
June	187	133	176
July	40	102	92
August	163	91	143
September	83	73	103
October	144	106	132
November	86	92	137
December	93	107	116
Total 1959 (9 months)	816	926	1,106
1960 January	150	139	167
February	76	87	126
March	166	152	169
April	161	105	161
May	175	127	182
June	46	54	77
July	106	78	98
August	146	96	130
September	96	68	84
October	45	33	49
November	236	160	198
1960 (11 months)	1,406	1,102	1,433
Total (20 months)	2,222	2,028	2,539

This first experiment cannot be considered a success. The pruning in the experimental areas was too light and the bushes will not run a full four-year cycle; skiffing may be necessary to keep them flushing.

Ferham No. 12 Field and Oddington No. 8 Field

In these two fields, the bushes were taken down considerably lower in the middle, to an extent amounting to a light prune; it is anticipated that these may run the full four-year cycle. At the end of eleven months, the bushes are some three feet high in the middle of the row and it is thought that a further two cycles will be necessary to get the desired height of five feet.

In each of these two fields, two acres was wedge-pruned and the remainder given a normal clean prune. In Table 2 and 3, I give the comparative yields per acre, together with the average estate yields each month.

TABLE 2.—(*Ferham No.* 12 *Field*)

	Made tea, lbs per acre (calculated at 23% outturn)		
	Plot 1 (2 acres) Wedge-prune	Plot 2 (25 acres) normal prune	Estate average yield
1960 January, February	263	180	195
March	175	151	114
April	115	124	111
May	94	97	102
June	102	64	59
July	95	71	52
August	82	72	58
September	118	70	43
October	105	50	42
November	162	247	116
Total (11 months)	1,398	1,050	892

The increased yield from wedge pruning over normal pruning in Ferham No. 12 field was thus 33% in the first eleven months.

TABLE 3.—(*Oddington No.* 8 *Field*)

	Made tea, lbs per acre (calculated at 23% outturn)		
	Plot 1 (2 acres) Wedge-pruned	Plot 2 (12 acres) Normal prune	Estate average yield
1960 January	86	39	100
February	184	87	80
March	233	229	125
April	148	188	112
May	338	198	118
June	175	165	65
July	154	106	49
August	169	93	49
September	142	107	45
October	108	80	40
November	262	258	109
Total (11 months)	2,009	1,552	892

The increased yield from wedge-pruning in this instance has been 29% in the first eleven months.

General

Acreage in these experiments was arrived at by bush counts in each field. At Oddington, the weight of green leaf have been recorded by the Conductor; at Ferham by the K.P., but this has now been changed to the Conductor. It will be noticed that the percentage increase obtained by wedge-pruning is very similar in Ferham No. 12 and Oddington No. 8. The pruning was similar.

The yields of individual fields are available for the past 27 years and I am going to request permission to wedge-prune one complete field on each estate as a more thorough test. The advantages of this method so far would appear to be (1) a considerable increase of crop, at any rate in the early stages; (2) at least double the amount of maintenance foliage; and (3) at the moment, a plucking table twice that produced from normal pruning.

In addition, if the idea proved generally successful, it could ease the problem of excess labour on estates, since 1 to 1½ extra pluckers per acre are required.

D. Roe

Ferham Estate,
Talawakele.

A USEFUL GROUND COVER FOR CLEARINGS

In his annual report for 1953, published in Bulletin No. 35, the Plant Physiologist reported favourably on the ground cover *Crotalaria clarkei*, but no further reference to it has been traced. Very few planters seem to know the plant, and its name still does not appear in the seed dealers' lists. This is a pity, because experience over the past five years suggests that it is a valuable plant during soil reconditioning and the re-establishment of tea; and also for planting up bare patches and along road and drain edges, particularly at higher elevations where *Stylosanthes gracilis* does not succeed.

The following notes are the results of experience in the Kandapola and Udapussellawa districts, and it is hoped that they will be of interest to others engaged in replanting.

C. clarkei is best sown in nursery beds. Direct planting of the small seeds in the field has not been successful owing to insect damage: this can be controlled in the nursery. Once the plants are about 3″ high they are easily transplanted to the field in suitable weather, and establish themselves quickly. After 4–5 months a dense low bushy plant is formed, only a few inches high. At about 7–8 months the plant puts up flower stalks, and seeding takes place. It has been found inadvisable to cut back the plant at this stage, as it may be killed. New growth starts after the seeds have ripened, and the total useful life of the plant is about 2 years.

C. clarkei has been found very useful during the early stages of soil reconditioning, covering the soil rapidly before the Guatemala grass can do so. If planted about 18″ apart on the contour it holds up a considerable amount of soil, forming a continuous live terrace.

Nothing appears to be gained by trying to save the plants when cutting down the Guatemala grass to ground level prior to holing and planting out the young tea. A new row of young plants put out centrally between the tea rows soon forms a carpet which is particularly useful where thatching material is in short supply.

C. clarkei grows from a single, comparatively shallow, root in much the same way as *Stylosanthes gracilis*, and presents no difficulty in control or eradication. No success has been achieved with cuttings. In mature tea there is a tendency for the flower shoots to 'sit up' wherever they can obtain support, but they are easily broken or pulled out of bushes with a weeding tool.

Insect pests have done very little damage to the plants once they are out of the seedling stage, and no caterpillars have been seen in the seed pods.

The successful growth of *C. clarkei* has been reported from Dickoya, Pussellawa and Hewaheta districts, in addition to those already mentioned. Further trial is necessary in Uva, where drought may be a limiting factor to growth.

Small quantities of seed may be available form the Superintendent, Glen Devon, Halgranoya, by the time this appears in print: once plants are established, estates should be able to grow their own seed.

J. H. Zair

Glen Devon Estate,
Halgranoya.
23rd September, 1960.

Note by Dr Hutchinson, Nematologist.—

As requested by Mr Zair, we tested *C. clarkei* to find out if it is a host for the Meadow Nematode. A limited test, using seedlings grown in Petri dishes, showed that Meadow Nematodes taken from St Coombs would enter and multiply within the roots.

Therefore, from the standpoint of reconditioning soil before replanting, *C. clarkei* cannot be recommended for estates having a nematode problem, because it would allow the nematodes to survive to infest the new tea. However, this should not discourage its use on estates not having a nematode problem, nor on infested estates as a ground cover in weak tea. In the latter case, covering the soil is a more important consideration and, in any case, tea itself is the best host for the Meadow nematode and the *Crotalaria* should not increase the infestation of the tea. If the *Crotalaria* grows satisfactorily, and marigold is not easily established, there is no reason why the *Crotalaria* should not be grown in mature tea infested with Meadow Nematode.

SUMMARY MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT ST COOMBS, TALAWAKELE, AT 9.30 A.M. ON FRIDAY, 3RD MARCH, 1961.

Present.—Mr F. Amarasuriya (Chairman), Messrs L. F. J. Smith (Chairman, Agency Section, Planters' Association of Ceylon), E. Muttukumaru, (Chairman, Low Country Products Association of Ceylon), B. Mahadeva, C.C.S., (Tea Controller), A. V. Richards (Director of Agriculture), R. M. Macintyre, R. J. Gilmour, R. D. Wedd, N. M. Sanders, D. E. Hettiarachchi, H. R. Fernando, M. P. Amarasuriya, W. H. W. Coultas, Dr D. L. Gunn (Director), Messrs G. A. D. Kehl (Administrative Secretary) and H. J. Balmond (Secretary).

Messrs R. C. Scott, C.B.E., A. R. Cathcart and H. E. Peries, O.B.E., C.C.S., intimated their inability to be present.

1. Minutes of the Meeting of the Board held on 2nd December, 1960

The minutes were confirmed.

2. Membership of the Board and Committees

(A) MEMBERSHIP OF THE BOARD.—The Board received the following reports:—

(1) Mr A. R. Cathcart of Haputale Estate, Haputale, had been elected to serve as Chairman of the P.A. from 1st March, vice Mr H. Creighton, who had resigned from the Chairmanship of the Association on 28th February. Mr Cathcart accordingly became an *ex-officio* member of the Board.

(2) Mr L. F. J. Smith of Messrs Whittall Boustead, Ltd., had succeeded Mr R. A. G. McMichen as Chairman of the Agency Section of the Planters' Association of Ceylon and, accordingly, became an *ex-officio* member of the Board.

(3) Mr R. C. Scott, C.B.E. (P.A. representative) had been renominated to the Board for a further period of three years as from 17-12-60.

(4) Mr N. M. Sanders (P.A. representative) had been renominated for a further period of three years as from 22-2-61.

(5) Mr R. D. Wedd (Agency Section representative) had been renominated to the Board for a further period of three years as from 1-1-61.

(B) Experimental and Estate Committee

The Committee's recommendations for Mr Allan Cameron to succeed Mr A. E. A. Wallace-Tarry, and Mr R. C. H. Price to succeed Mr E. N. Whitfield were accepted.

(C) Low-Country Sub-Committee

Mr M. P. Amarasuriya was nominated to fill the place vacated by Mr Creighton.

The Chairman thanked the outgoing members and welcomed the new members.

3. **Draft Minutes of the Meeting of the Low Country Sub-Station Committee held on the 14th and 16th February, 1961**

Dr A. W. R. Joachim, O.B.E., the Low Country Adviser, was present by invitation.

The purchase of land suitable for the establishment of the low country sub-station was discussed and on the proposal of Mr Mahadeva, seconded by Mr Hettiarachchi, the Board unanimously agreed that an offer on terms specified be made to the Saffragam Tea and Rubber Company for the Kahahengama Division of Palm Garden Group, including the bungalow and 25 acres of paddy situated within the division.

Mr Hettiarachchi then expressed, on behalf of the low country and the Board, his deep gratitude and appreciation of the assistance given by Mr Gilmour in solving this long outstanding problem.

The Director proposed that the Board record its appreciation of Dr Joachim's devotion and contribution to the establishment of a Low-country Sub-station.

The Chairman endorsed the sentiments of both Mr Hettiarachchi and the Director, and the Board unanimously recorded its appreciation of the services rendered by Mr Gilmour and Dr Joachim in the establishment of the Low-country Sub-station.

4. **Minutes of the Administrative Committee Meeting held on 19th January, 1961, and Financial Appendix.**

The minutes of the Administrative Committee meeting held on 19th January were considered.

(1) Page 4. Item 4(2)—Appointment of Statistician

Reported that the draft bill had been approved by the Cabinet and awaited Parliamentary approval.

The Board decided that, as the delay in this appointment was seriously inconveniencing the planning of experiments, an approach be made to the Minister of Finance for the release of the officer concerned pending approval of draft legislation.

The Board then approved the minutes of the Administrative Committee meeting held on 19-1-61 including the financial appendix thereto amounting to Rs. 12,170/-.

5. **Draft Minutes of the Experimental and Estate Committee Meeting held on 11th February, 1961, and Financial Appendix**

The draft minutes of the Experimental and Estate Committee meeting held on 11th February, 1961, including the financial appendix, were approved with the following amendment.

MINUTES 4.5—TECHNOLOGY: that a group consisting of the Chairman, the Director, the Technologist and Mr N. M. Sanders should visit Tocklai early in June to investigate the continuous-flow roller (CR 2). The vote of Rs. 5,500/- to cover travelling expenses was approved.

Staff Matters

(1) DIRECTOR'S LEAVE

Reported that the Director would be taking his leave from the 19th June to 26th July, 1961 (inclusive). The report was received.

(2) DR A. W. R. JOACHIM, LOW-COUNTRY ADVISER

Reported that Dr Joachim had been invited to serve on the National Education Commission and it was proposed that the time involved on this assignment would be considered duty leave. The report was received and Dr Joachim was allowed duty leave for this prupose.

(3) MEDICAL BENEFITS

The Board authorised the issue of railway warrants at T.R.I. expense to all staff for visits to Kandy or Colombo to see a medical specialist, or for dental treatment, provided that the need for each such visit was certified by the local Government Medical Officer or by the Medical Officer of the Dimbula Medical Scheme, except where a person was too ill, or where a medical certificate indicated that T.R.I. transport was necessary.

(4) EDUCATION FACILITIES: PROVISION OF TRANSPORT TO NUWARA ELIYA

A proposal for the provision of bus transport for children attending school at Nuwara Eliya was considered and the Board deferred action pending enquiries as to whether the Ceylon Transport Board could run a school bus for this purpose.

7. **Other Business**

(1) AMENDMENTS TO THE ORDINANCE

The Board approved the draft Act.

(2) TENDERS

The recommendations of the Building Committee were approved.

On the proposal of Mr Macintyre, seconded by Mr Smith, the Board resolved that its Seal be used on the contract documents relating to the construction of these buildings.

H. J. BALMOND
Secretary

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5. **Draft Minutes of the Experimental and Estate Committee Meeting held on 11th February, 1961, and Financial Appendix**

The draft minutes of the Experimental and Estate Committee meeting held on 11th February, 1961, including the financial appendix, were approved with the following amendment:

Minute 13—Technology; that a group consisting of the Chairman, the Director, the Technologist and Mr S. M. Bandara should visit Turkey early in June to investigate the continuous tea roller (CP 21). The vote of Rs. 3,500/- to cover travelling expenses was approved.

Staff Matters

(1) Director's leave

Reported that the Director would be taking his leave from the 19th June to 30th July, 1961 (inclusive). The report was received.

(2) Dr A. W. R. Joachim, Low-country Adviser

Reported that Dr Joachim had been invited to serve on the National Education Commission and it was proposed that the time involved on this commission would be considered duty leave. The report was received and Dr Joachim was allowed duty leave for this purpose.

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H. J. [illegible]
Secretary

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